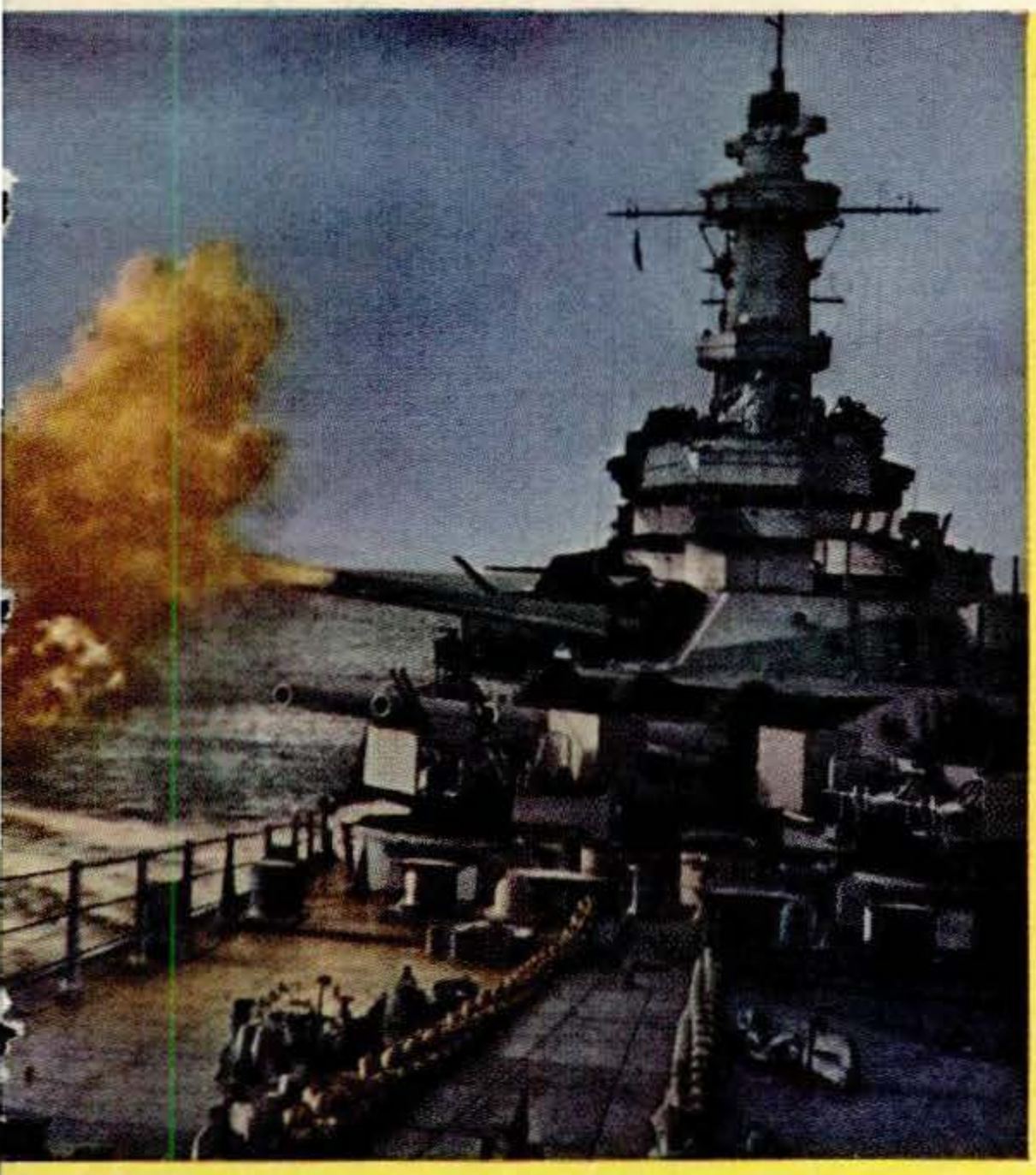
POPULAR SCIENCE MONTHLY

FEB. 25¢



CAN THE JAPS TAKE THIS? Are their secret superdreadnoughts a match for our Iowas? Page 90

READY FOR POISON GAS. How U. S. troops are protected at all times against surprise attacks. Page 106

JAP FIGHTER. Plans for an accurate scale model of one of the enemy's newest and best planes. Page 148

GREEN GOLD. Wyoming prospectors pick up fortunes in American jade that rivals China's. Page 112

HOW WE LANDED RAILROADS ON FRANCE'S BEACHES PG. 76

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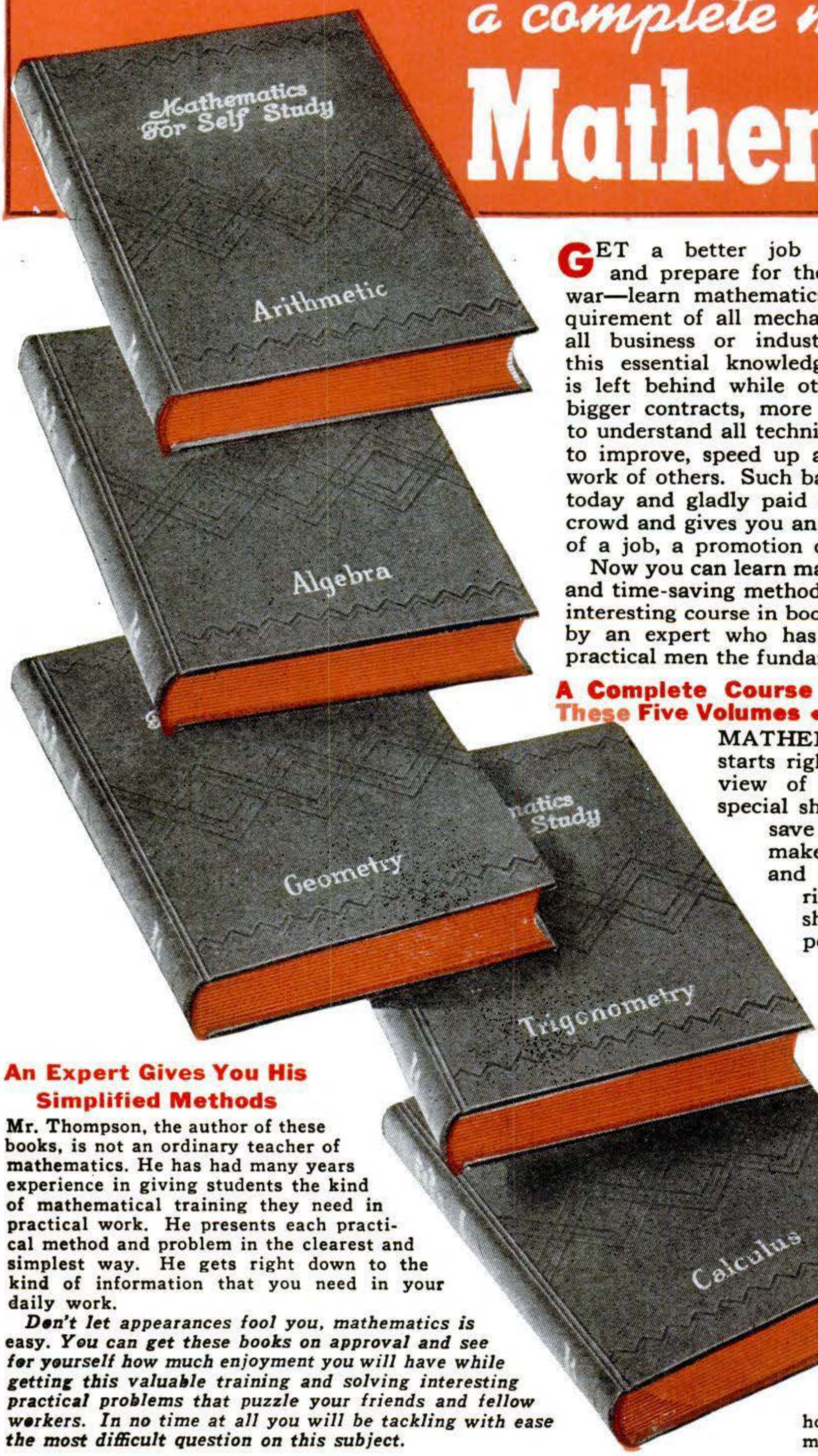

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(Continued on next page)

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(Continued from facing cover)

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POP. SCIENCE 2-45

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War shortages crop up in strange materials. Mica, for instance. Once seen principally in the windows of stoves, and in small boys' pockets, it is now used extensively as electrical insulation. In some war products, it is virtually indispensable: capacitors for radio, spark-plugs for airplane engines, insulators in electronic tubes.

With demand mounting, manufacturers were desperate. A four-man technical mission flew to London to help ration the world's supply between the United States and Great Britain. The shortage was serious.

The War Production Board, convinced that much mica was classified too low when judged by appearance alone, asked Bell Telephone Laboratories to develop a new method of electrical tests. The Laboratories were able to do this quickly because of their basic knowledge and experience in this field.

The new tests were made available to manufacturers in this country and abroad—the supply of usable mica was increased 60%—and a difficult situation relieved.

Skill to do this and other war jobs is at hand in Bell Laboratories because, year after year, the Laboratories have been at work for the Bell System.

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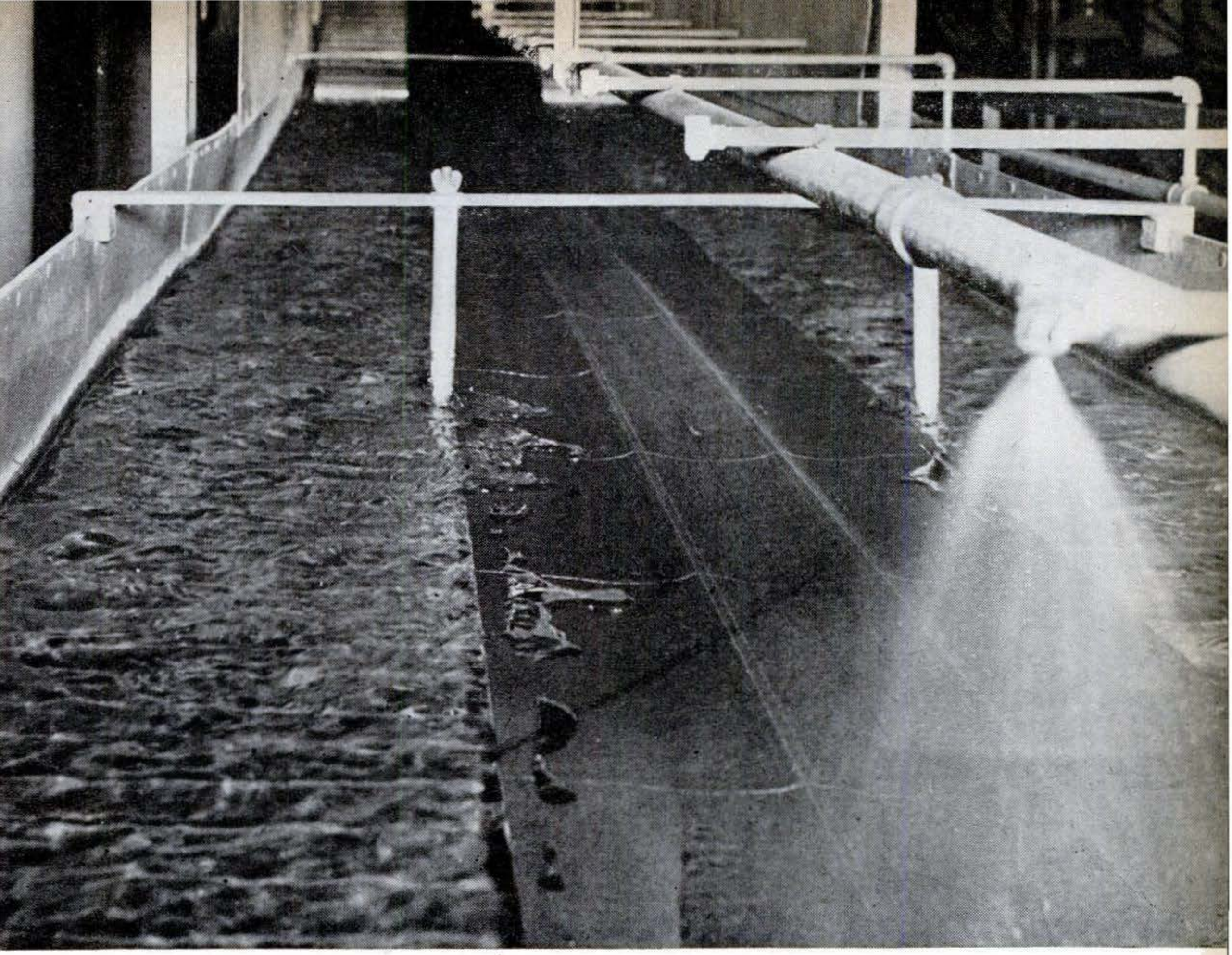

Where tire treads go swimming

No other rubber company makes tires this "odd" way . . . a typical B. F. Goodrich improvement

B. F. Goodrich engineers put a "river in a factory" to make tires that wear longer. Soft, uncured rubber for tire treads—the part that rolls on the road—used to be squeezed out through an opening, like tooth paste out of a tube. The opening gives the right shape.

But the rubber always had to be worked, or "milled," a long time before it was soft enough to squeeze through—and milling always takes some of the strength from it. Even the largest and best tire manufacturers had long accepted this as an unavoidable loss of quality.

Then B. F. Goodrich men developed a machine that *rolls* the rubber through the opening instead of squeezing it through. It can handle firmer, tougher dough, with much less milling. Then they added the water conveyor shown above, to carry the tread away from the machine. A continuous stream of rubber flows into the water and floats along with it—carried without being distorted or strained while it is still new and hot.

No other tire is made today with this new kind of tread. It's one of the reasons why B. F. Goodrich synthetic-rubber tires are wearing so well today. Another, of course, is the fact that B. F. Goodrich made and sold tires containing synthetic rubber three years ahead of every other manufacturer.

Continuous research at B. F. Goodrich has just one purpose—better tires—for cars, trucks, farm or special purposes. Because B. F. Goodrich all-synthetic tires are backed by this policy of constant improvement, they give you extra wear, extra safety, extra value. The B. F. Goodrich Co., Akron, Ohio.

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. . . Yes, we're sure to be ready when the time comes. Our production plans will be all set. And when we get the "go-ahead", we'll start to make "the Ford in your future."

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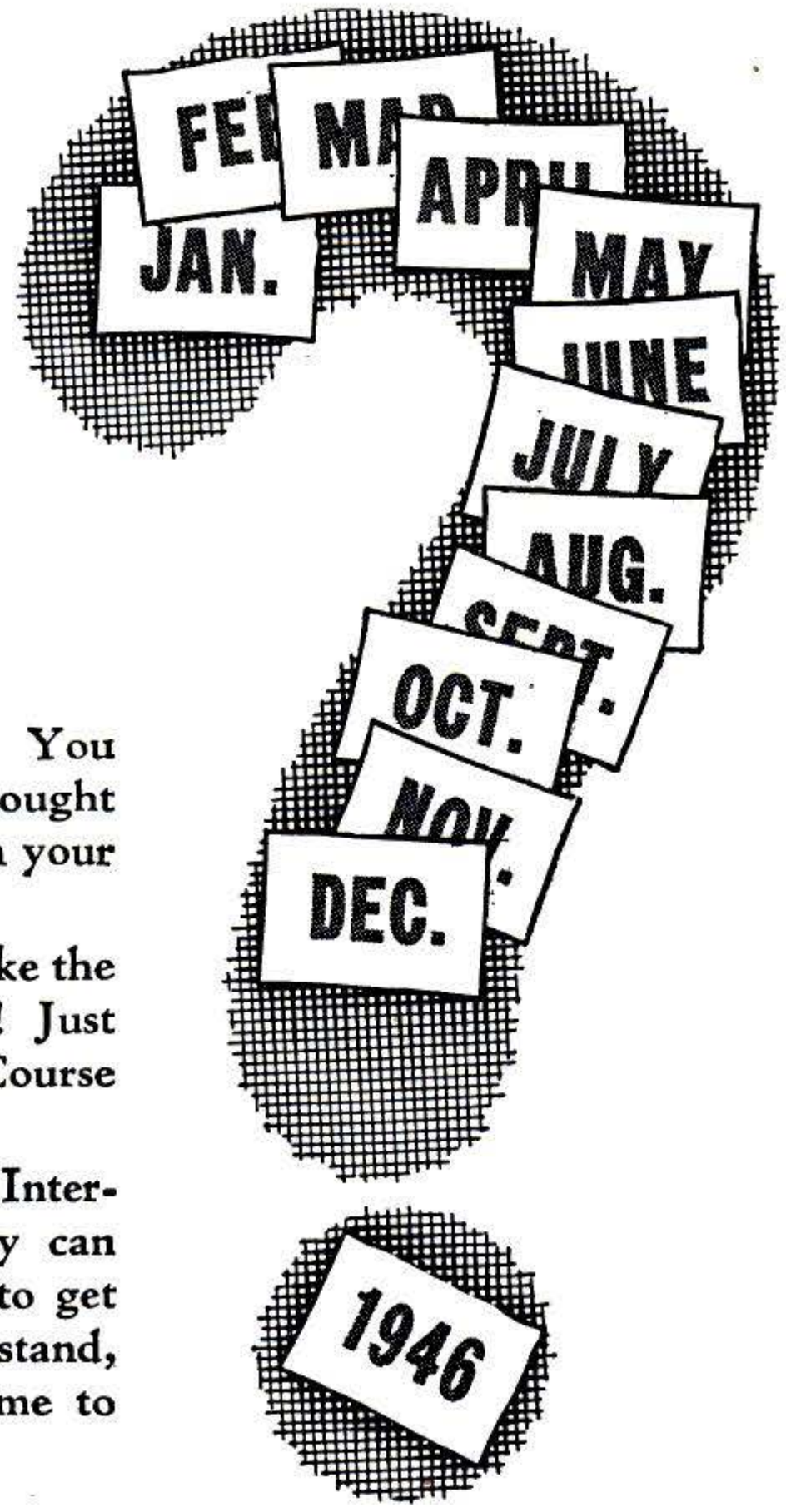

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POPULAR SCIENCE

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Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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FORTY-FIVE YEARS AGO, a university professor blew a hole in a heavy steel safe with a tiny charge of dynamite. His amazing discovery, reported at the time in Popular Science Monthly, is the secret of the destructive power of the bazooka and other modern weapons. See page 65.

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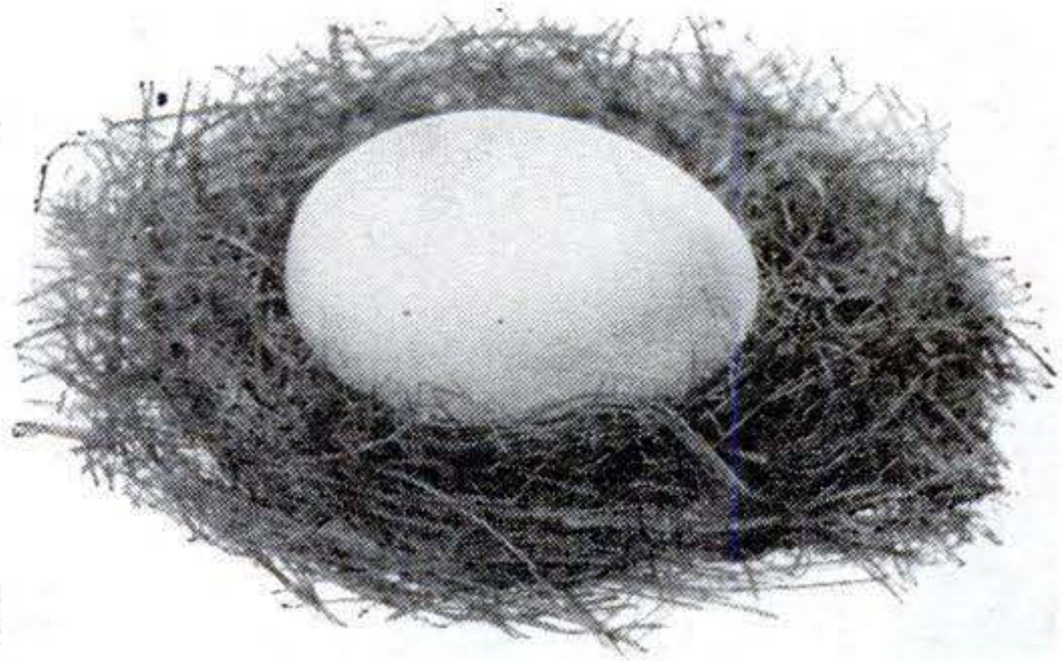

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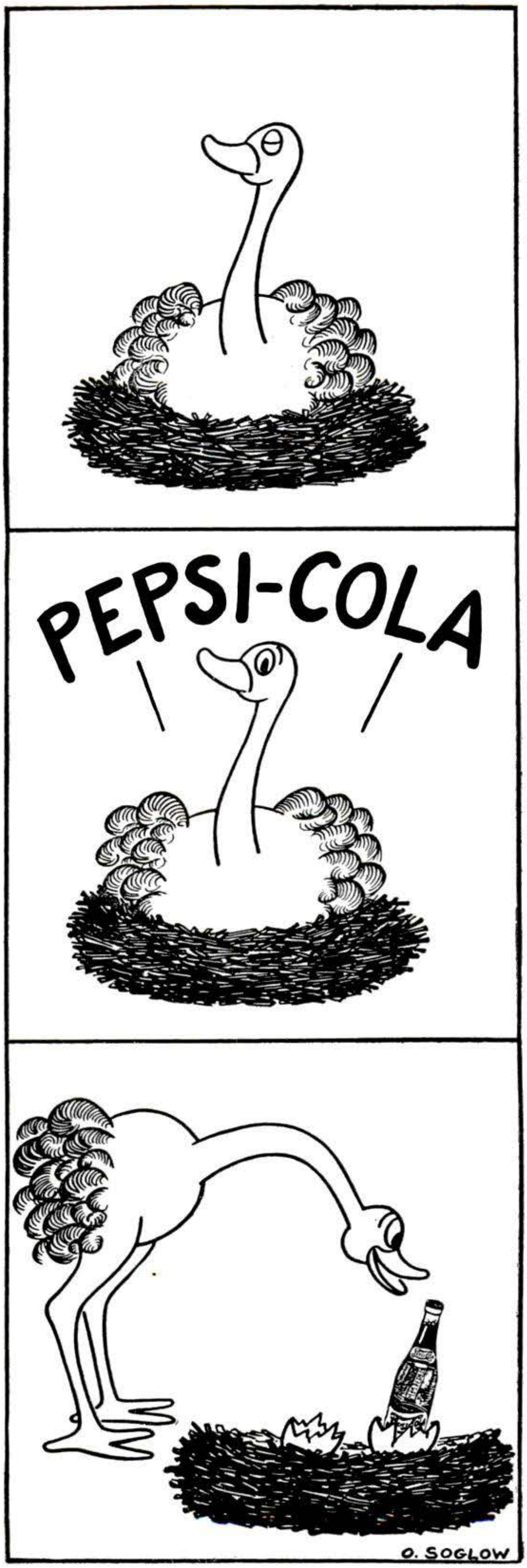

Coming Next Month

WHAT WE'RE UP AGAINST. Following up recent articles on Japanese air and seapower, Popular Science presents a thorough study of the land weapons of our enemies in the Pacific. Tanks, artillery, small arms, and ammunition all come in for appraisal and comparison with our own comparable weapons. The war news will mean more to you after you read this illuminating article.

COPPER ranks next to steel as the most-used metal in peacetime. In war, it is a vital necessity. How did America meet the pyramiding demand for copper in this global war? Hal Borland describes the methods of mining and refining that supplied our needs for electrical wiring, alloys, and shell cases. You'll be thrilled by this story of another wartime triumph of U. S. science and industry.

WANT TO BUY an Army field-telephone set? That's just one of countless items the Government will offer at bargain-counter prices in disposing of surplus war stocks. Popular Science is offering $200 in prizes for the best letters from readers telling what they want to buy from this immense stock—and what they'll do with it. Watch for full details of this contest, with lists of merchandise.

LIGHT is the paintbrush with which the photographer gets his effects. Camera enthusiasts now have at their disposal a wide choice of artificial illumination, but they sometimes fail to make the best possible use of it. Konrad Cramer gives practical advice on lighting setups and tells how to get the most out of these magic aids to lenscraft.

THE PLANES YOU'LL FLY. It was exciting to read the results of the Popular Science contest "The Plane You'd Like to Own." But even more important than finding out who won is the analysis of the entries to see what the private flyers of tomorrow are going to demand in their postwar planes. A careful breakdown of the entries reveals the percentages of preference on all features dealing with comfort, safety, and performance.

NAVY TUGS are playing a heroic though unsung role in the war at sea. Model builders will welcome the chance to reproduce one of them in miniature, in a waterline model scaled to 1/8 inch to the foot. Easy to build from the detailed plans and instructions, the model represents one of the 65-foot towboats that lend a helping hand to our fighting ships in home waters.

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AN UNUSUAL TRUE STORY

It May Have a Tip for You

"No, I can't talk to you. I am not interested in a correspondence course in Accounting and besides, I have a bowling date for tonight."

That's what our representative heard one day two years ago from a bright young man, high school graduate and bookkeeper for two years in a western city. Let's call him Jim, although that isn't his real name.

Just a month or so before, this same LaSalle representative had enrolled for the very same training another young man (let's call him Bert) recently arrived from Europe and then working as an office boy in the same town at $15 a week. Bert worked enthusiastically, aggressively in his spare time on his study.

A year later our representative was asked, as they so often are, to recommend a successor to the chief accountant of Jim's company, a successor to the man under whom Jim worked. He recommended Bert and Bert was hired—as Jim's boss and at a salary considerably larger than Jim received. Four months later, Bert was made comptroller and given another salary increase.

A month later, Jim enrolled for the training which he had turned down a year before and he has since had a salary raise. He had been badly disappointed but he saw the point. He decided that he would not make the same mistake twice.

An Unusual Story—Yes

It doesn't often happen exactly as it did in this case. But in essence it does happen far more frequently than you suspect.

For business, when it has an opening, looks first to its own present employees to see who is ready and prepared for the job. But if, as so often happens, it finds no one, then it goes outside for the person it wants.

Don't blame the employer. Nine times out of ten, he would prefer a man or woman already experienced and familiar with company policies and methods. But he knows that long, loyal service in the job below may not be enough—he must have trained ability for the position.

That's why business watches its employees so eagerly—to see who is ambitiously and systematically preparing for promotion. We hear it over and over again—this note of gratitude when we tell an employer (as we do on request of any student) that some employee of his is training with us for better service to him.

Can It Happen to YOU?

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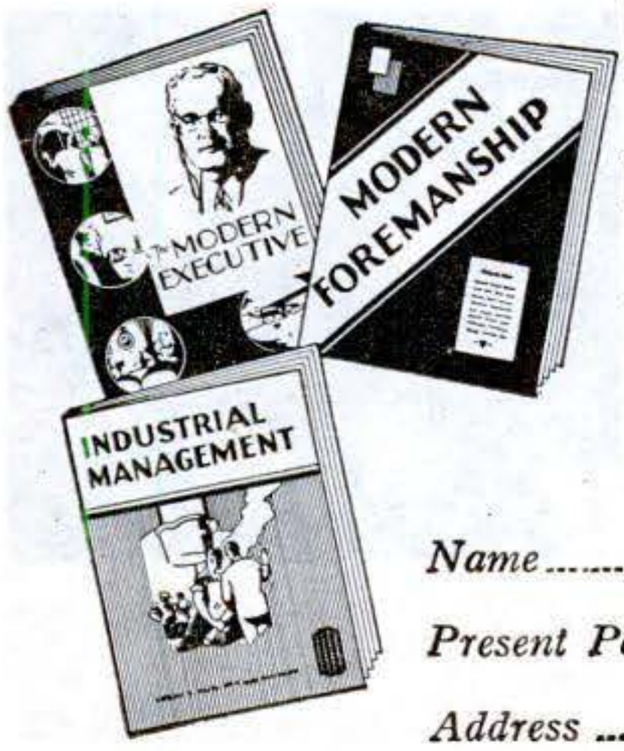

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$50 a Month in Spare Time—"I have a spare time Radio and Electrical business of my own which has been very profitable, due to the efficient training I received from your Course. Last year I averaged over $50 a month."—FRED H. GRIFFIE, Route 3, Newville, Pa.

Transmitter Network Engineer—"I began my N.R.I. training while 16 years old and still in high school. Am now transmitter engineer here for one of the big networks."—THEODORE CAMPBELL, Johnstown, Pa.

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RADIO SERVICING (picture above) pays Technicians good money, spare or full time. RADIO OPERATORS (picture at right) find interesting work in U. S. Broadcasting and other types of Stations.

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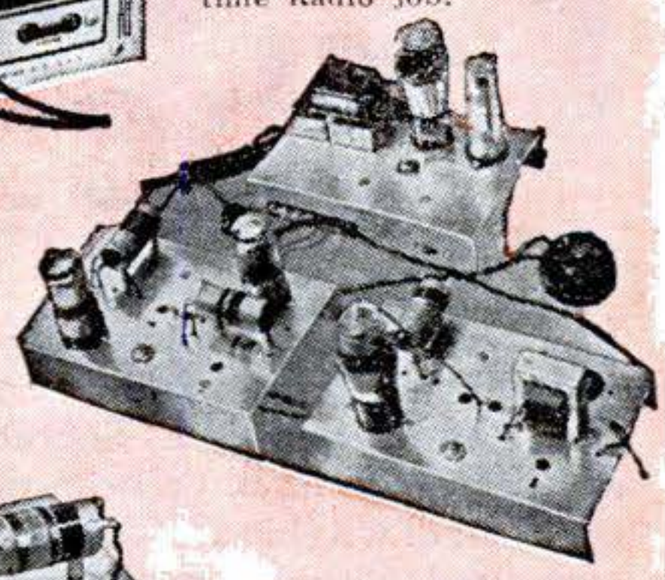

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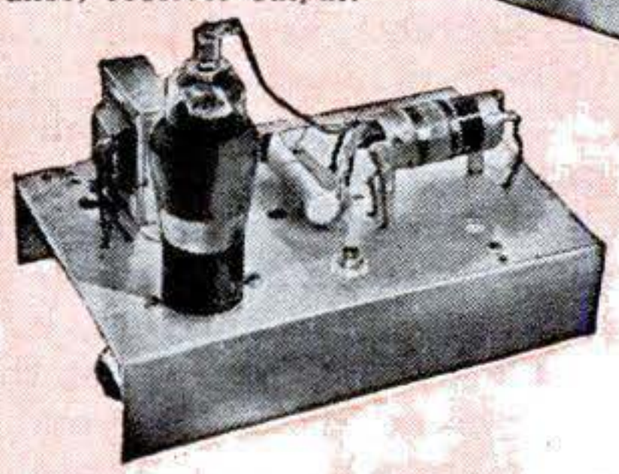

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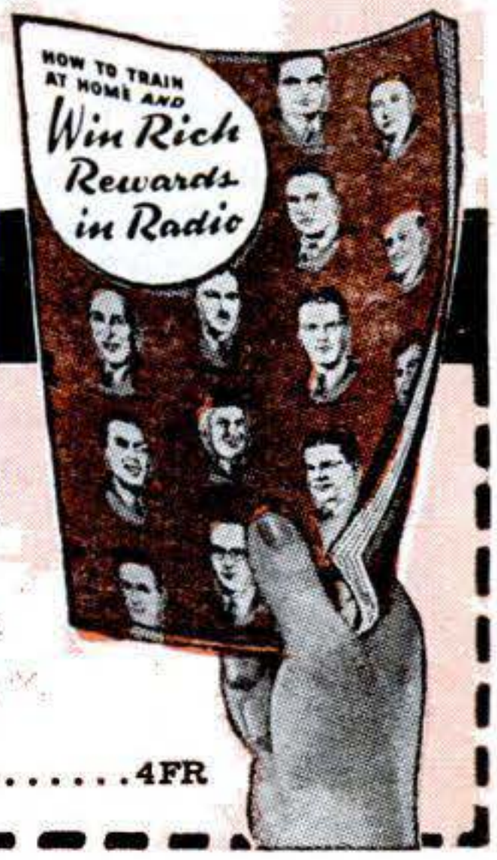

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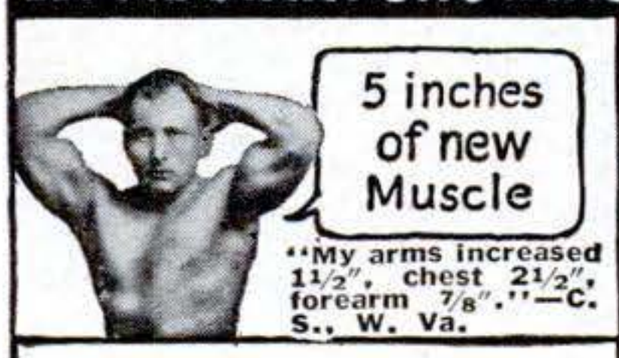
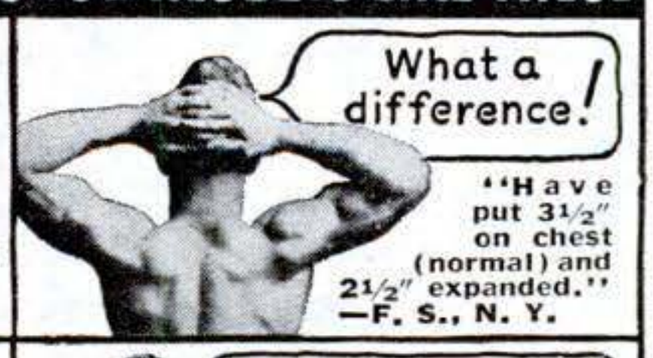
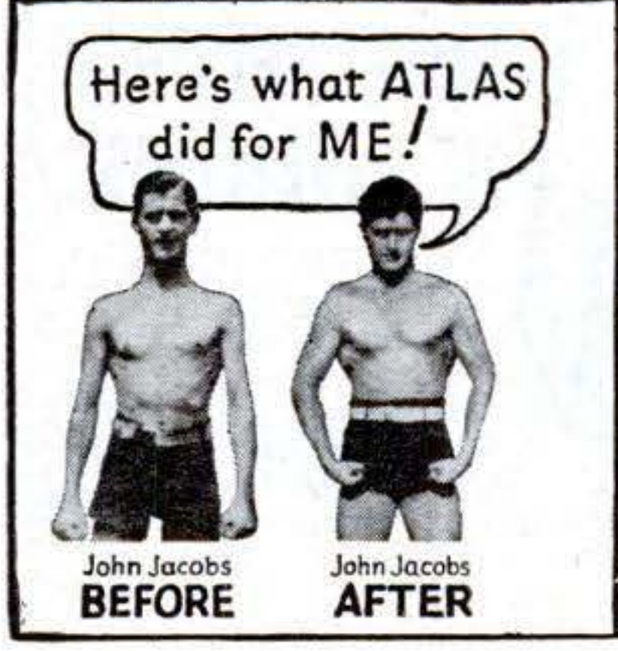


"My arms increased 1½", chest 2½", forearm ⅞"."—C. S., W. Va.



"Have put 3½" on chest (normal) and 2½" expanded."—F. S., N. Y.



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"When I started, weighed only 141. Now 170."—T. K., N. Y.

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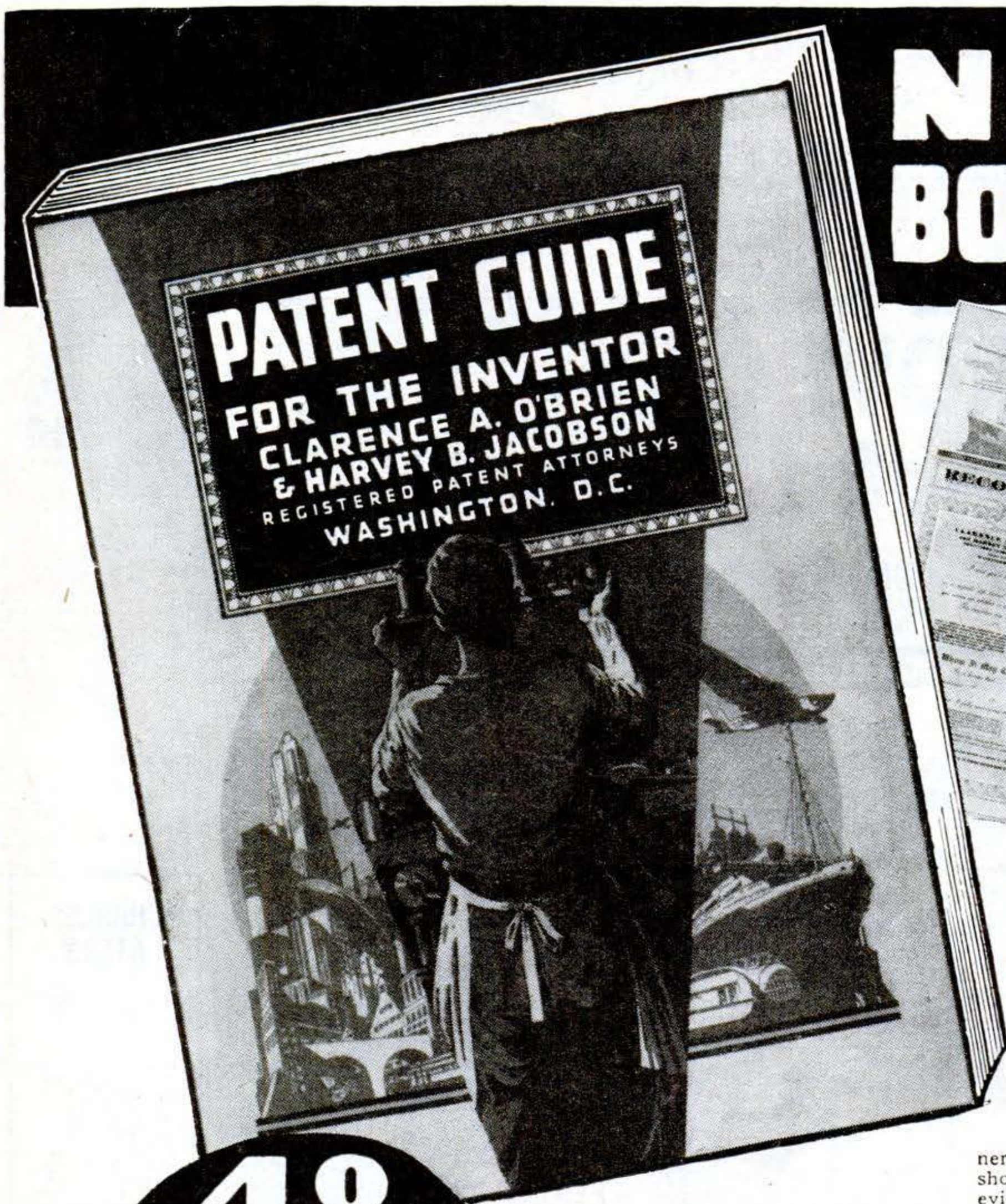

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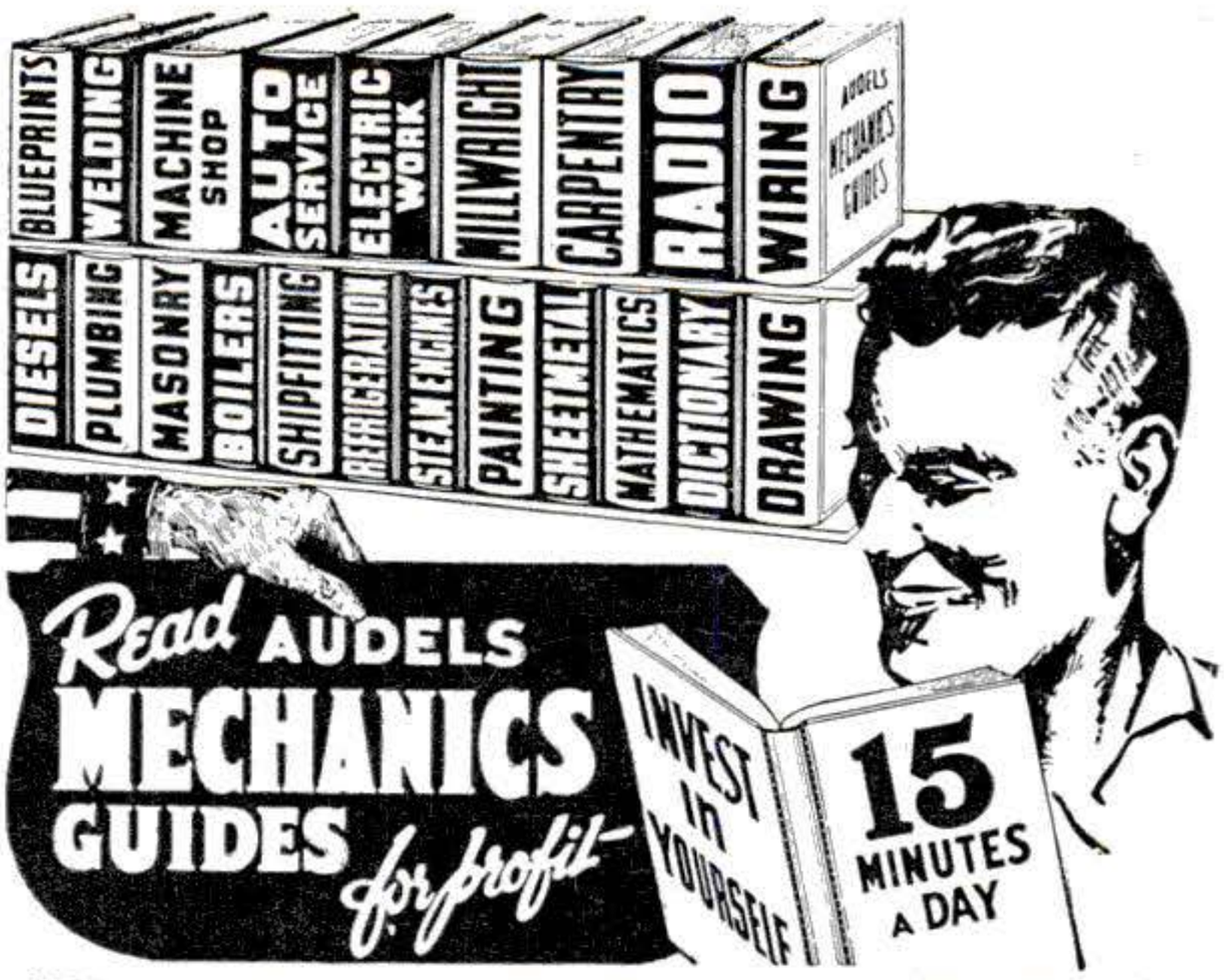

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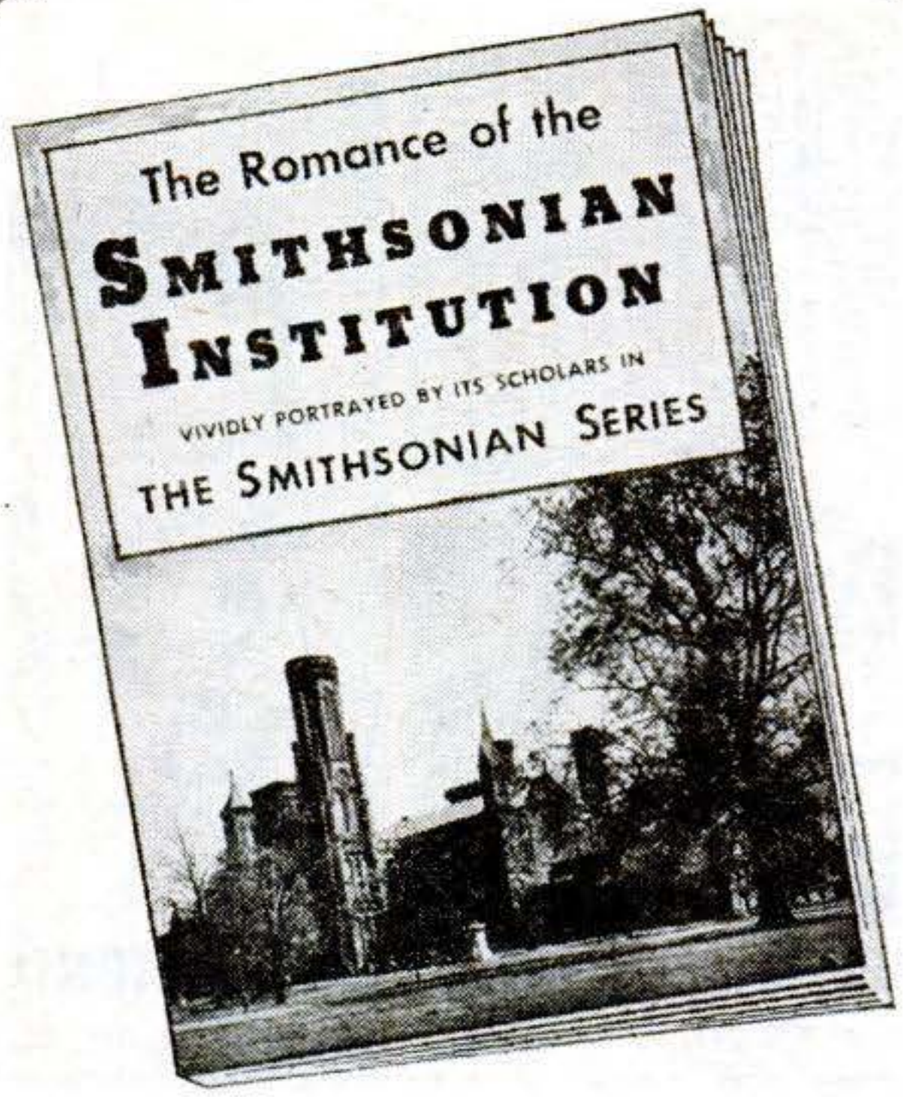

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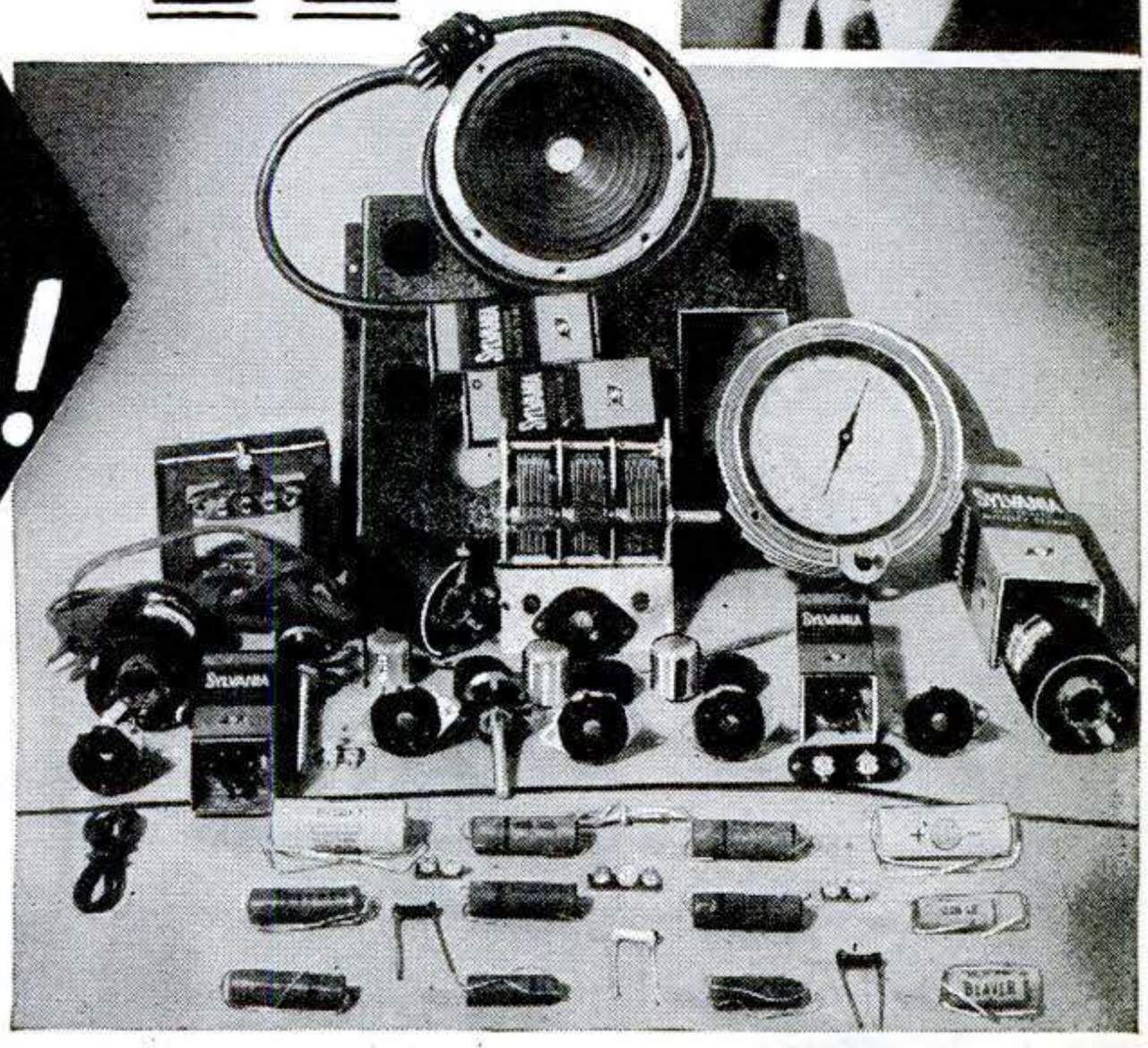

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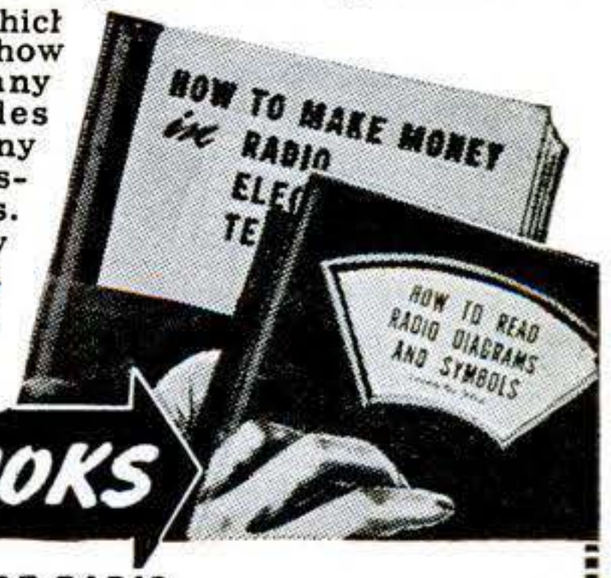

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Flanked by a copy of P.S.M. telling about the $1,000 postwar-plane contest, Don Fotheringham works on sketches for design that brought home the bacon

Something More About Fotheringham from a Buddy in the Marines

HERE are some more details about Pfc. Don L. Fotheringham, of the U. S. Marine Corps, from a fellow leatherneck:

The winner of first prize (nonprofessional class) in the POPULAR SCIENCE contest "The Plane You'd Like to Own" is all of 17 years old, and a veteran member of the fighting Fourth Marine Division. Born February 19, 1927, in Salt Lake City, Utah, he had to bamboozle his way into the Marine Corps. This was when he was 16 and a student at the Idaho Falls, Idaho, junior high school.

First, he showed up at his local draft board, told authorities there that he had just turned 18, and registered. Measuring close to five feet 10 inches, and tipping the beam at 162, he had little difficulty. Next, he headed for the nearest Marine recruiting office, pulled out a brand-new draft registration card, and said, "I want to enlist." He was accepted.

Then came the toughest job: getting his parents to see eye-to-eye with him. But he jumped that hurdle and was sent to the Marine Corps Base at San Diego, Calif., for recruit training. While there, he qualified as a rifle marksman and expert with the bayonet. His first real duty in a Marine uniform found him at a Naval air station in Washington doing guard duty. It was while stationed there that he was bitten by the bug to get into aviation. The clincher came when he was granted a furlough and hitch-hiked home in a Flying Fortress, the first plane ride he ever had. Before he left for overseas, his parents again tried to talk him into going back to school. They even offered to register him in a military academy. Said he: "That's kid stuff; I'm a Marine now."

And out here nobody will deny it.

Shortly after the Marshall Islands campaign, his true age and the details of his enlistment were discovered. The Fourth Marine Division, however, had important business to attend to in the Marianas. So Fotheringham was left behind at a rear base pending investigation. The matter was cleared up to everyone's satisfaction, and the Marine again joined his buddies in the Fourth.

According to his contest entry, his occupation is "kicking hell out of the Japs so that I can return home to the following type of plane."—T/Sgt. Martin Kivel, USMC, Somewhere in the Pacific.

They Could Have Done It Equally Well with a Lion

I FIND the math problems in this department most interesting. Here is one I'd like to pass along: Two hunters shot a deer. Determined to find out what the deer weighed, and not having a scale with them, they proceeded as follows: Knowing that their own weights were 120 and 180 pounds respectively, they placed a fence rail across a log so that when one of them sat on each end of the rail, they balanced each other. Then, by exchanging places, they found that they again balanced when the 120-pound hunter held the deer. What was the animal's weight? — R. E., Milwaukee, Wis.

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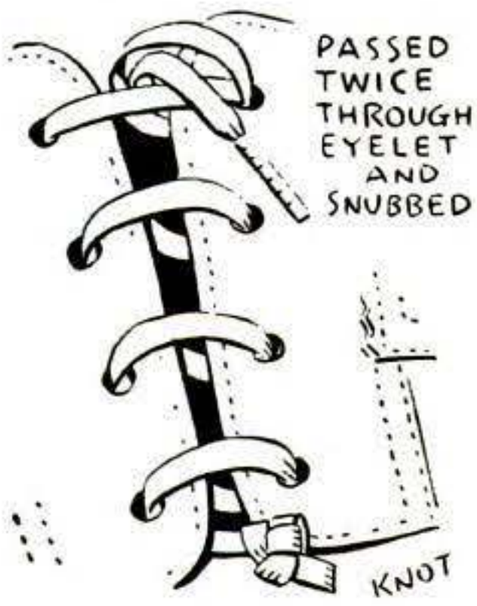
One-Armed Man Gives Tip on Tying Shoelaces

THIRTY years ago, at the age of nine, I lost my right hand in a dynamite explosion. Since then I have learned a lot of little tricks to get along without having to ask help from those around me. Here's a suggestion that may be helpful to some of the brave boys who have lost a hand in the war: Lacing and tying shoes is no problem for a normal person, but it can be troublesome to a one-armed man. I cut off one end of my shoelace and make a double knot at this end. Through one of the two lowest eyelets I push the tip end up and draw it taut, so it is anchored by the knot. Then I thread the lace, as shown in the illustration, until it comes out the last eyelet, when it's a simple matter to make it fast by passing it through the eyelet again, and pulling it taut. It is easy to undo it, too, but it will hold securely until it is time to remove the shoe.—P. C., Montreal, Canada.



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WHAT I don't know about airplanes would fill quite a decent-sized volume. One thing especially has puzzled me. It's this: some of the planes that pass over my house at night seem to have blinking lights, first on the wings and then on the tail. Is this my imagination, or is it some signaling system? And if it really is so, how is the blinking thing accomplished?—C. D. W., New York City.

It's no imagination, C.D.W., the lights really do blink. Soon after war began, all commercial airlines adopted blinking tail lights of alternate red and white flashes. Most airline transports now have not only blinking red and white tail lights, but a blinking red light on the left wing tip and a blinking green light on the right wing tip; also, in some cases, additional blinking white lights above and beneath the fuselage cabin. It is purely a safety measure, and is used only in the United States.—Ed.

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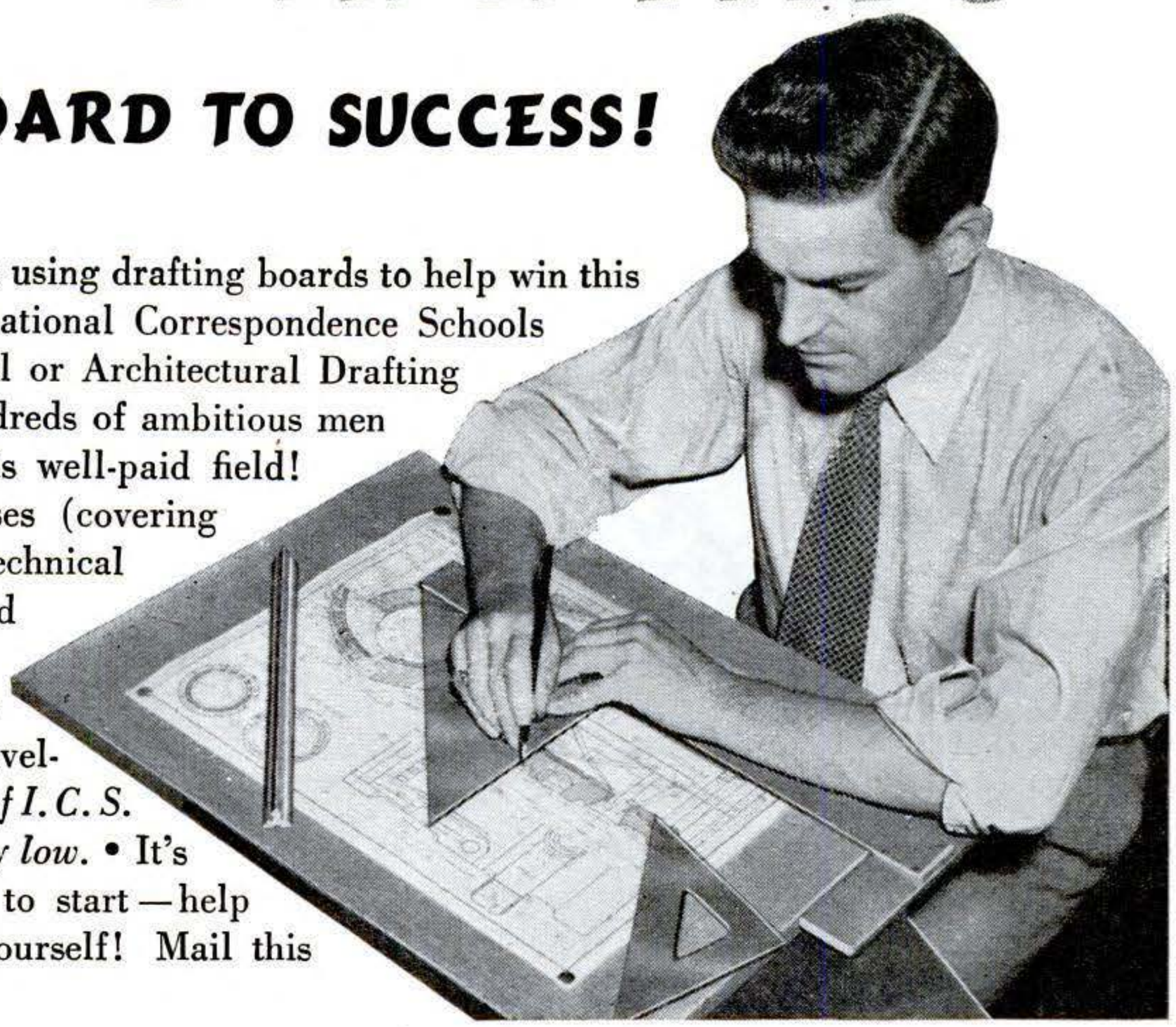

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This Writer Tells Why He Takes Ouija Seriously

IN YOUR December number a person asks for an explanation of the Ouija board. Since my mother used it, I am qualified to give the needed information. No one can get results with it alone unless he has mediumistic abilities, but often two people can get results even if they know nothing about how it is done. The spirits do the manipulating by controlling the muscles that move the pointer to spell out what they want. The spirits can do nothing that a human being can notice unless there is some medium that they can draw power from to accomplish the result; the better the source of power, the better the result.

My mother used her Ouija board for many years, and got great comfort and pleasure from it. In one case it foretold an event accurately.—A. V. B., National City, Calif.

A Fair Question; but Tell Us Where to Get the Steak

SOME of the boys were having an argument about using the new radio waves in cooking, and we got on the subject of how much control there is. Here is my question: If you froze a steak in a block of ice, would it be possible to fry or broil the steak without melting the ice?—H. G., U. S. Naval Training Center, Farragut, Idaho.

Using short radio waves from a powerful diathermy apparatus, it should be possible to cook a steak without melting a block of ice surrounding it. Only the ice immediately in contact with the steak would be liquefied, by the heat of the meat itself. The heating effect is due to electric current set up in a conducting object by the short radio waves, and the steak would be a much better conductor of electricity than the ice. Therefore, no directional or focusing control would be required in this case. Since ultrashort radio waves can be controlled by suitable reflectors, however, there seems to be no reason why they could not be directed or focused exactly like beams of light.—Ed.

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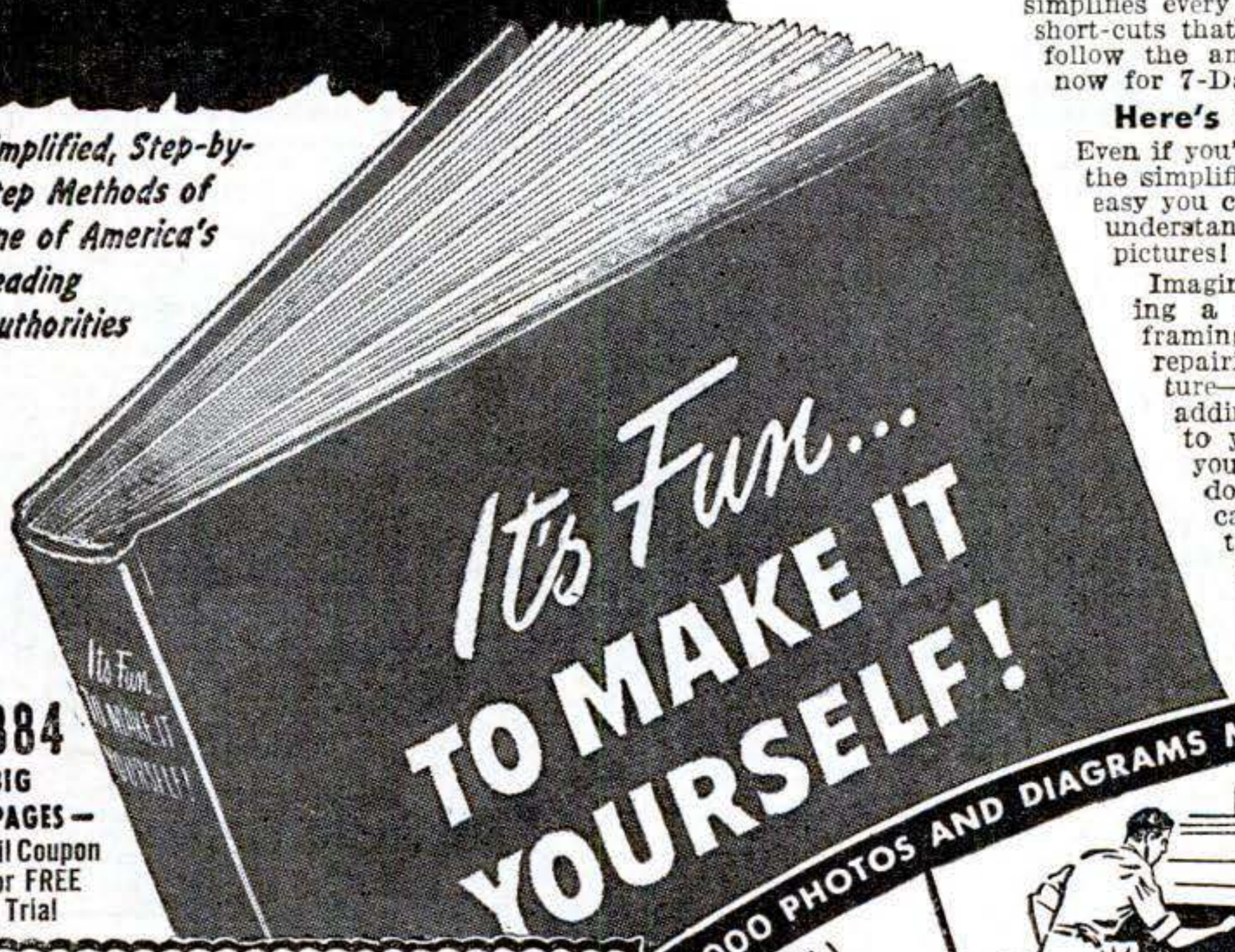

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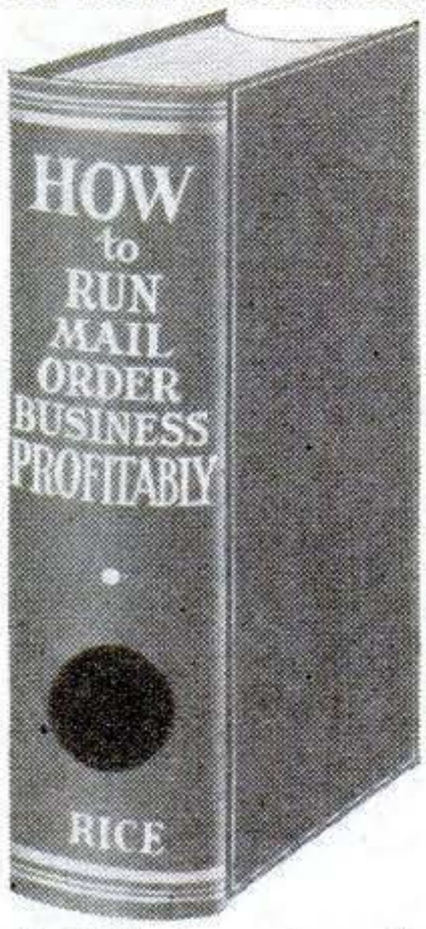

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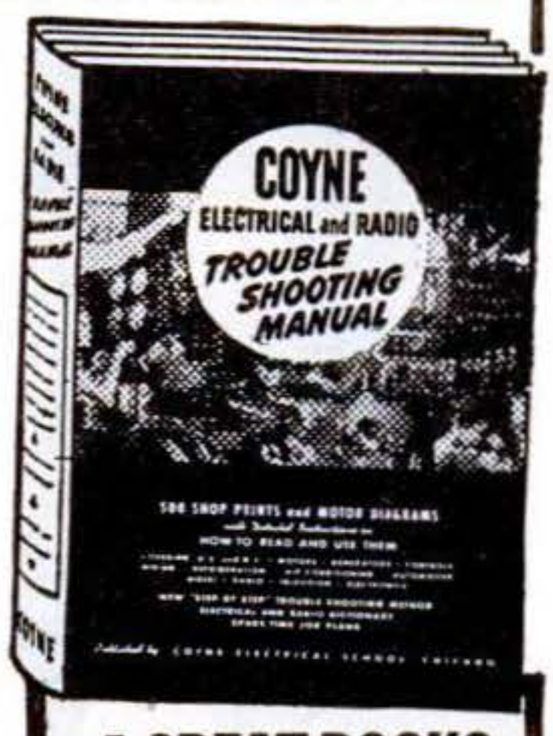

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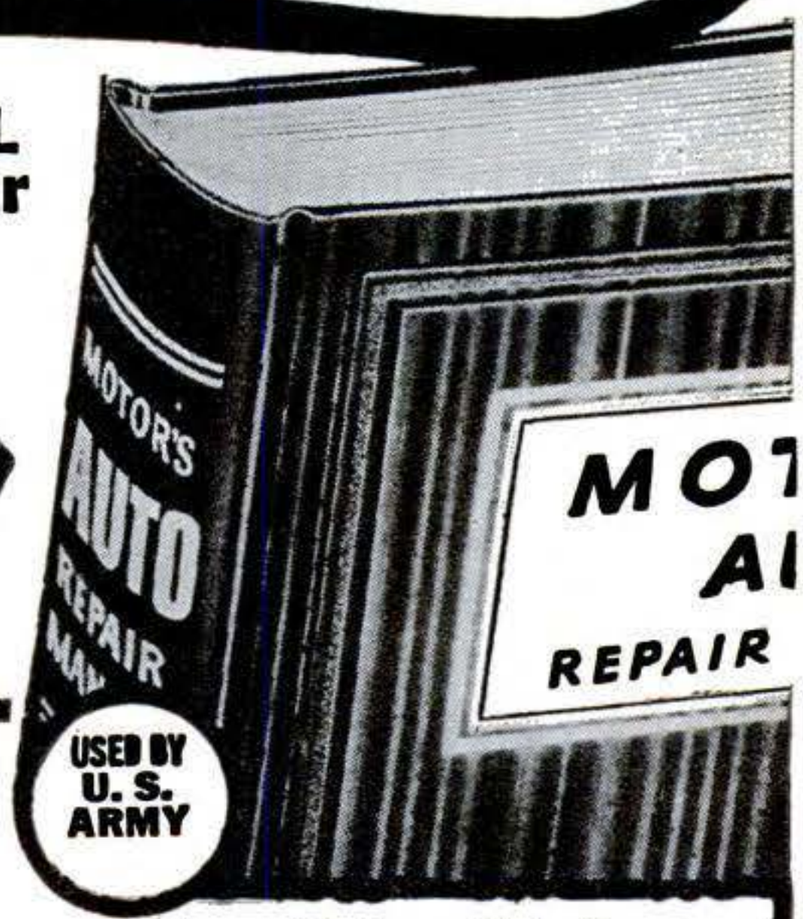

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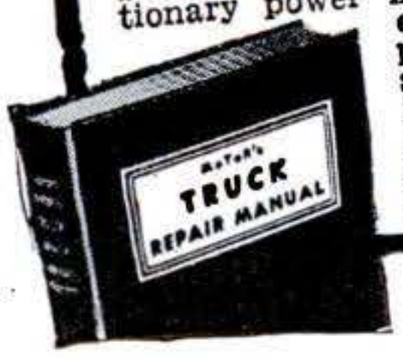

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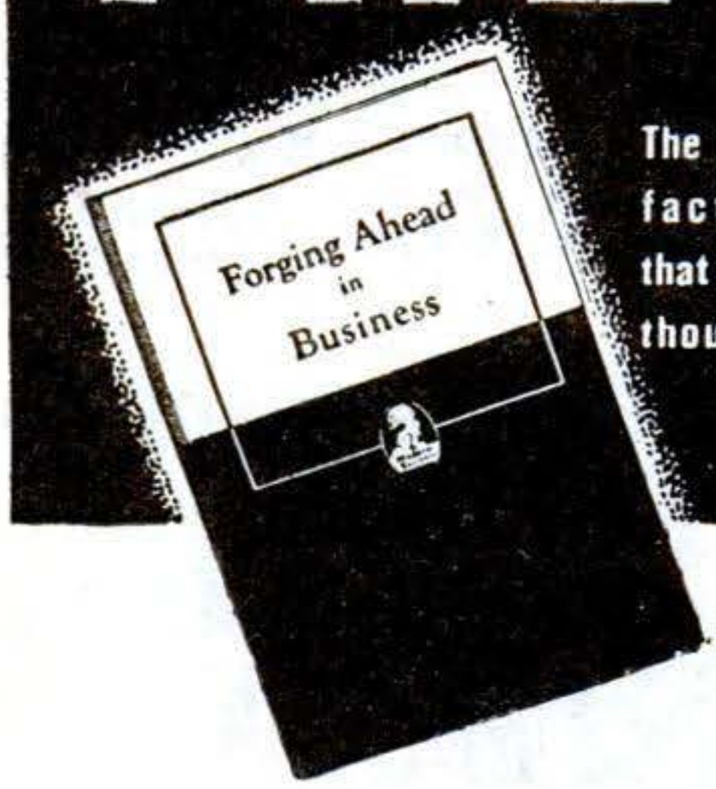

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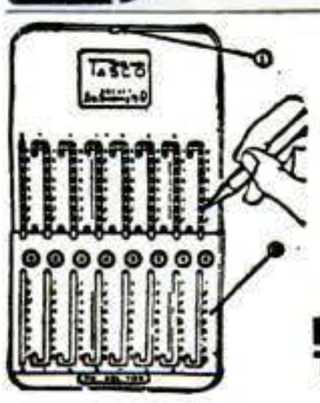

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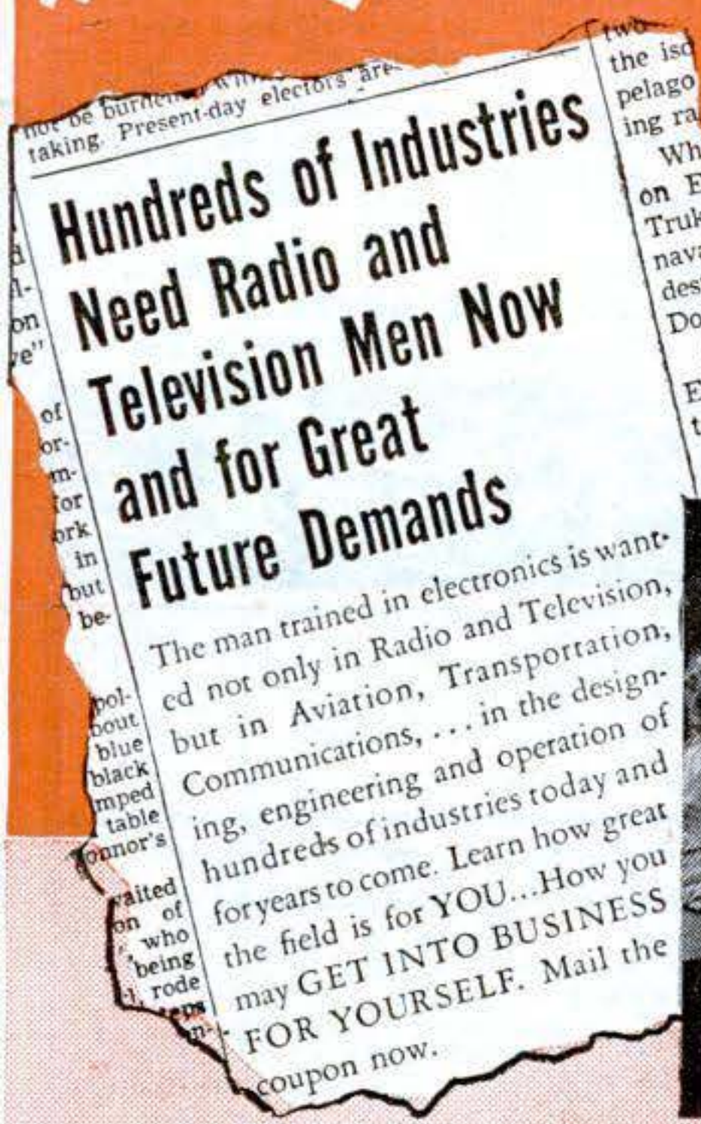

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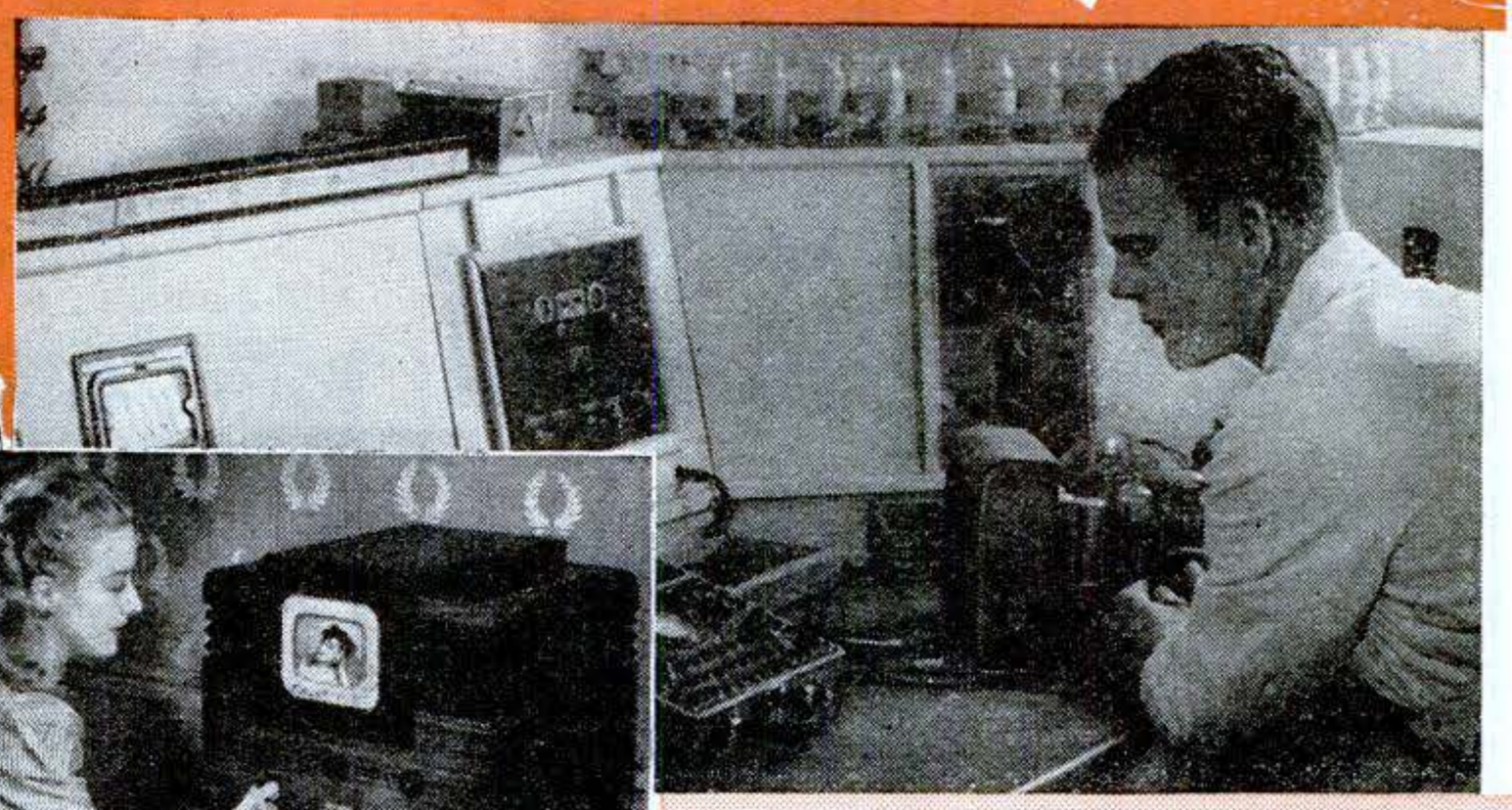

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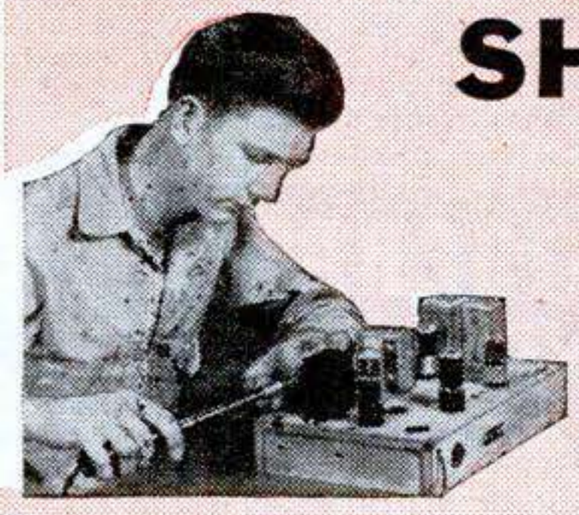

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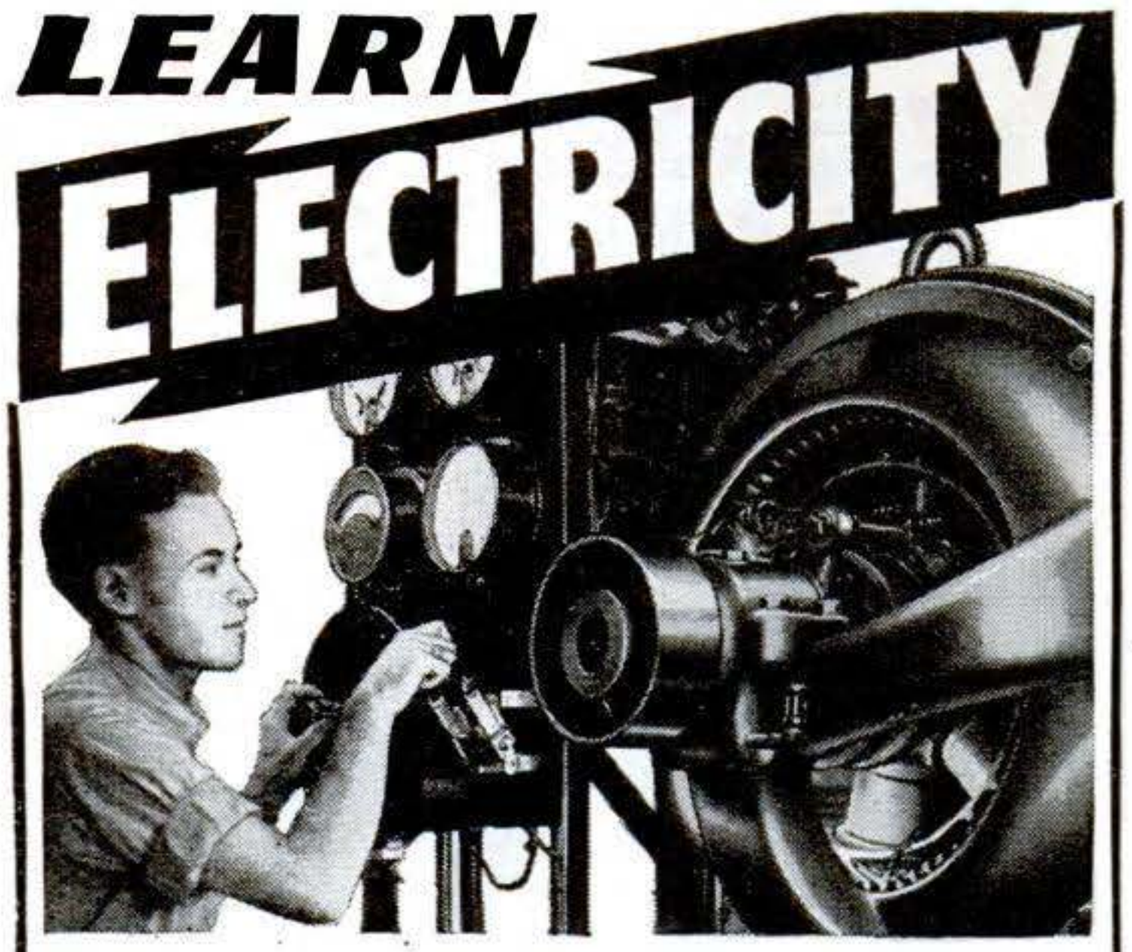

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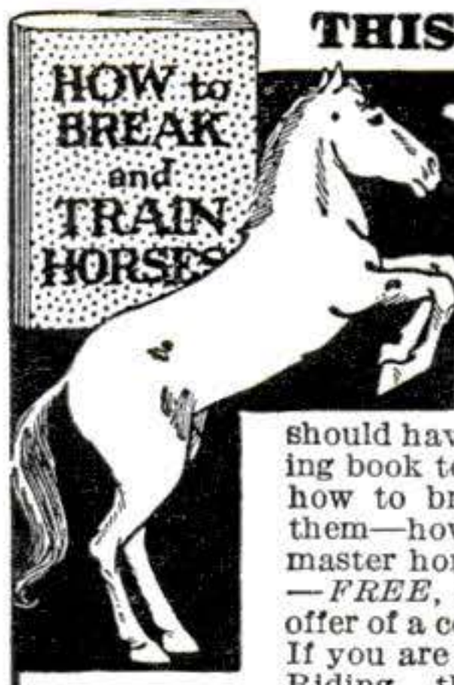

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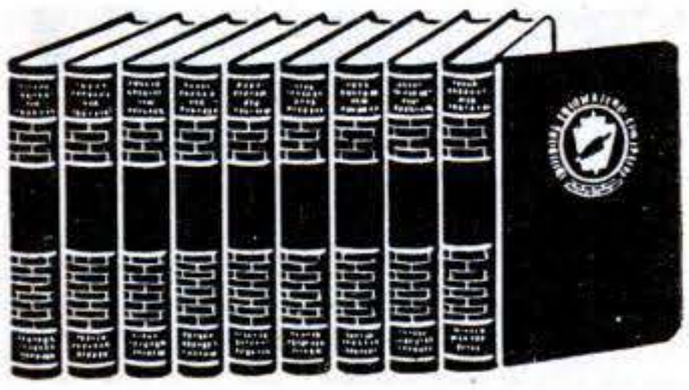

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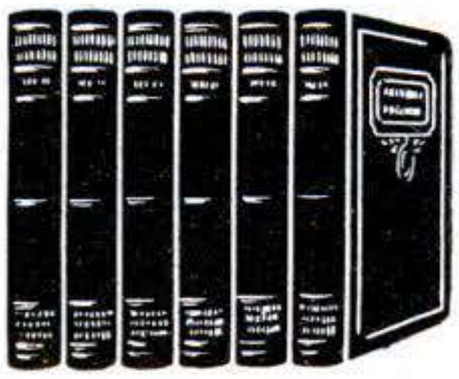

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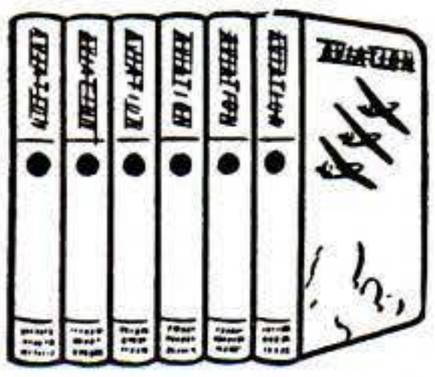

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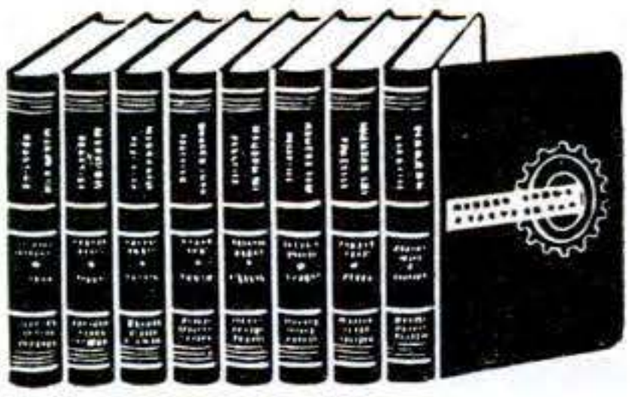

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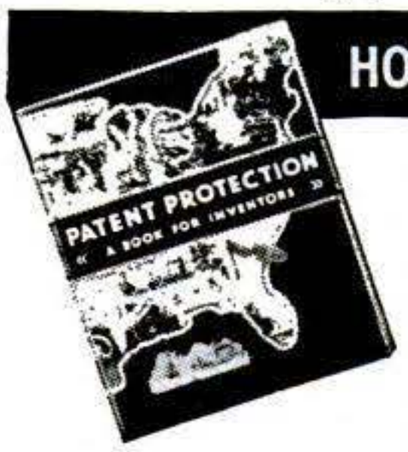

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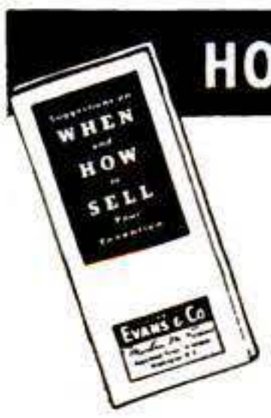

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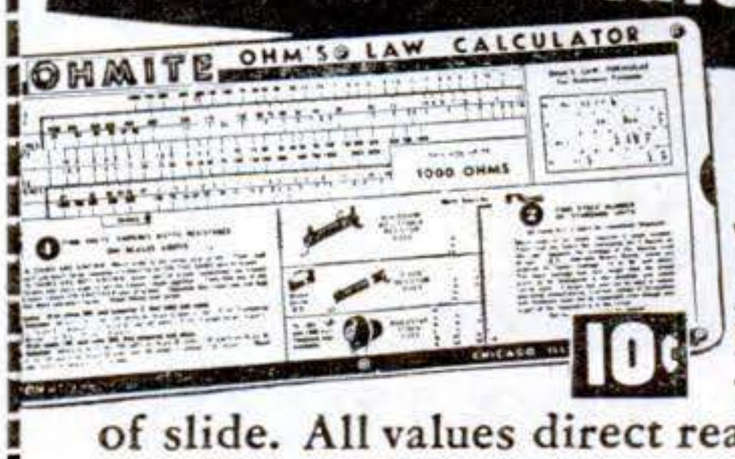

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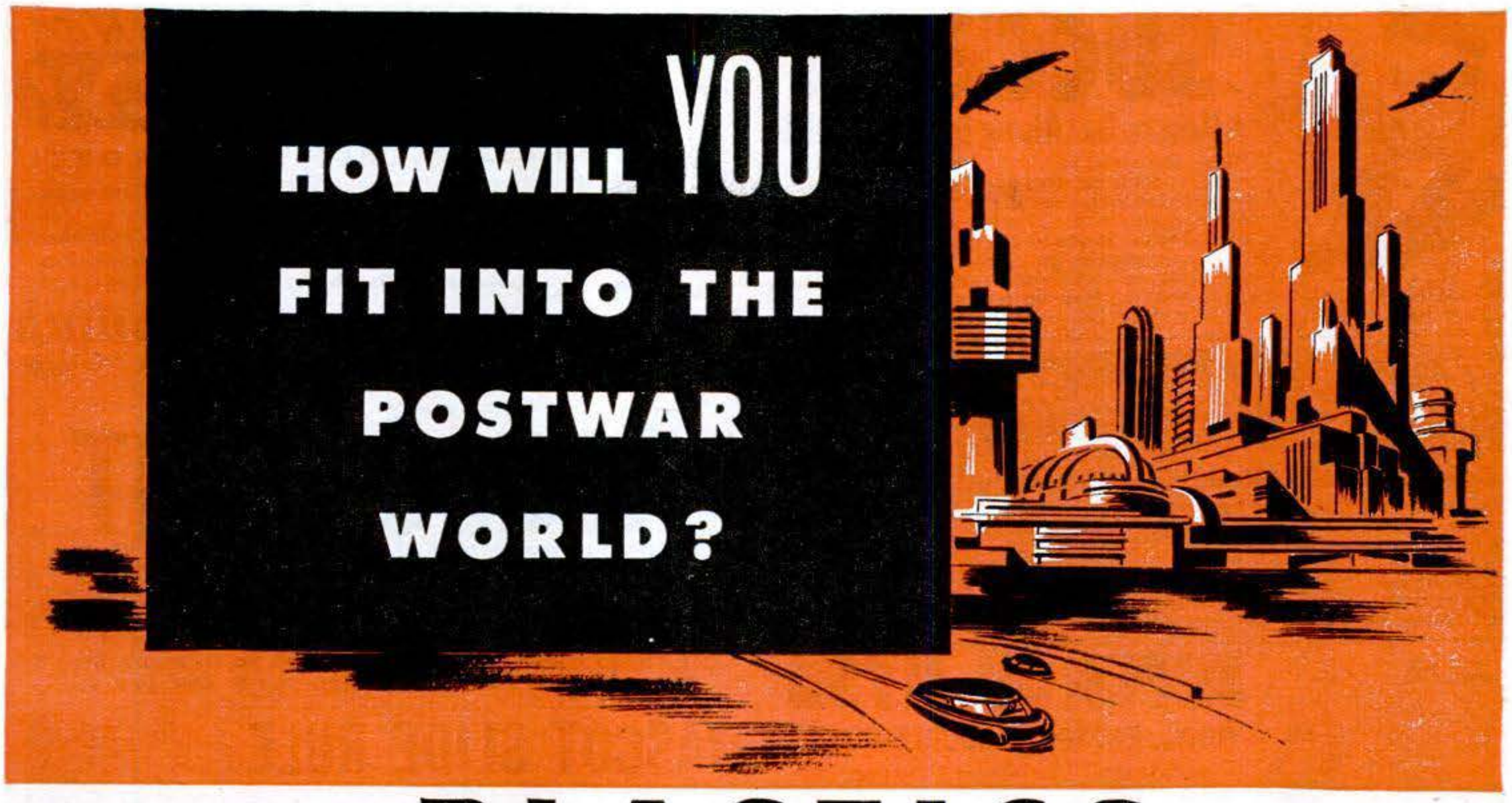

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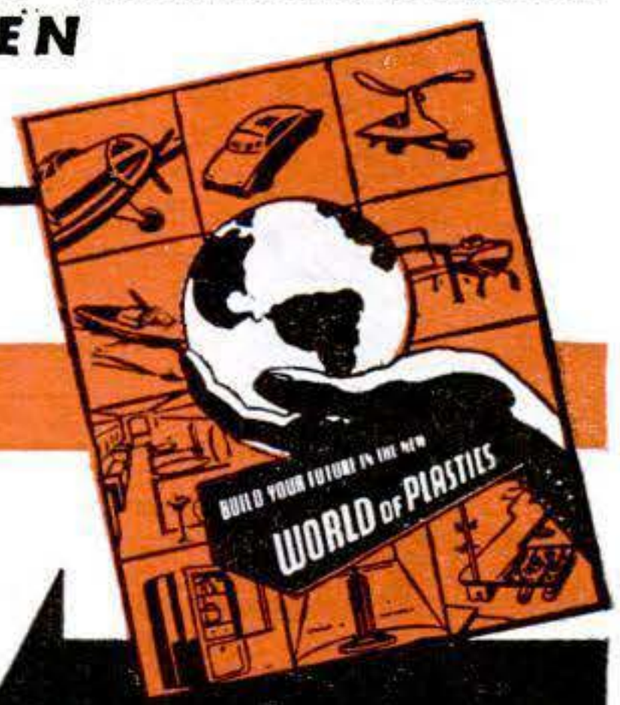

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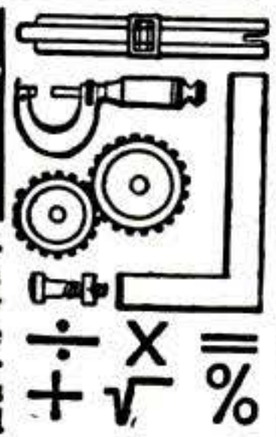

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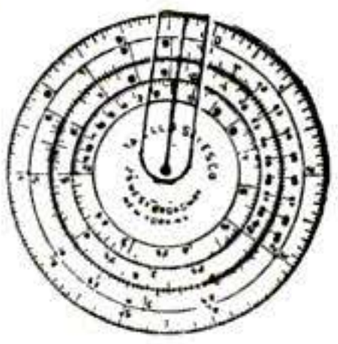

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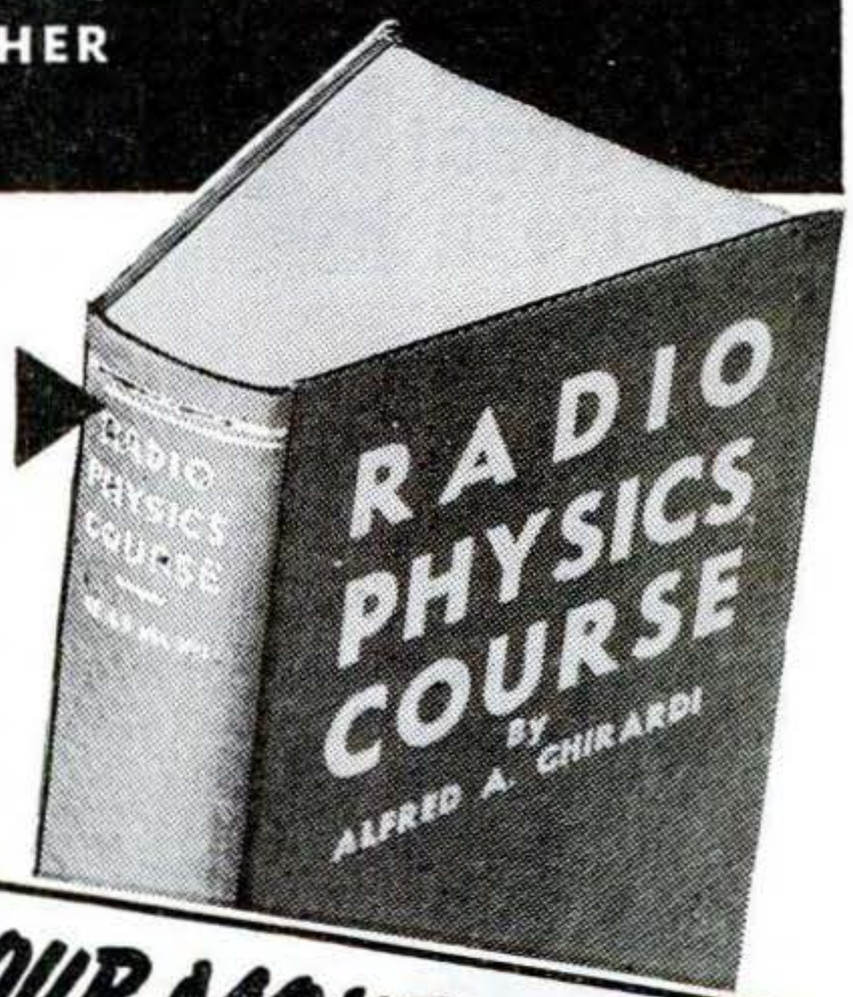

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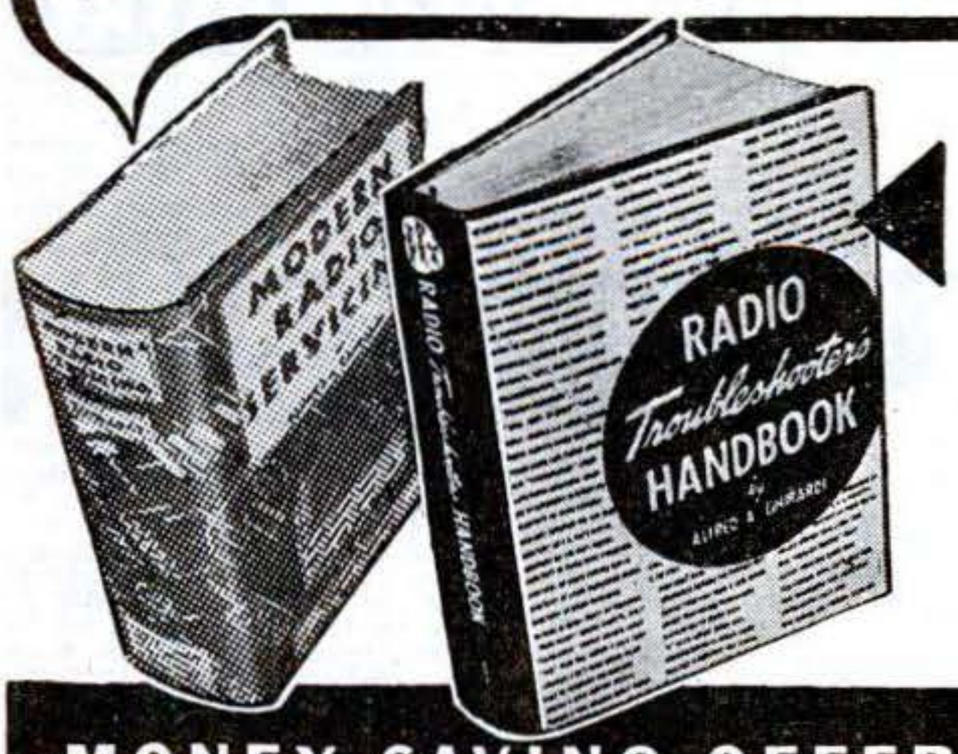

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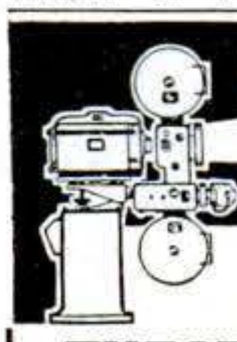

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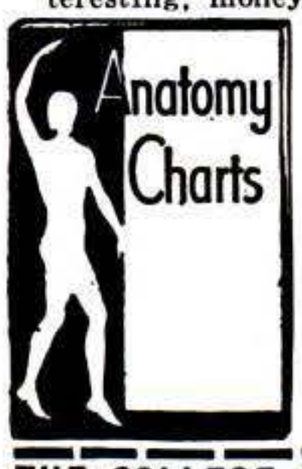

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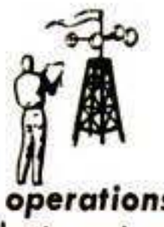

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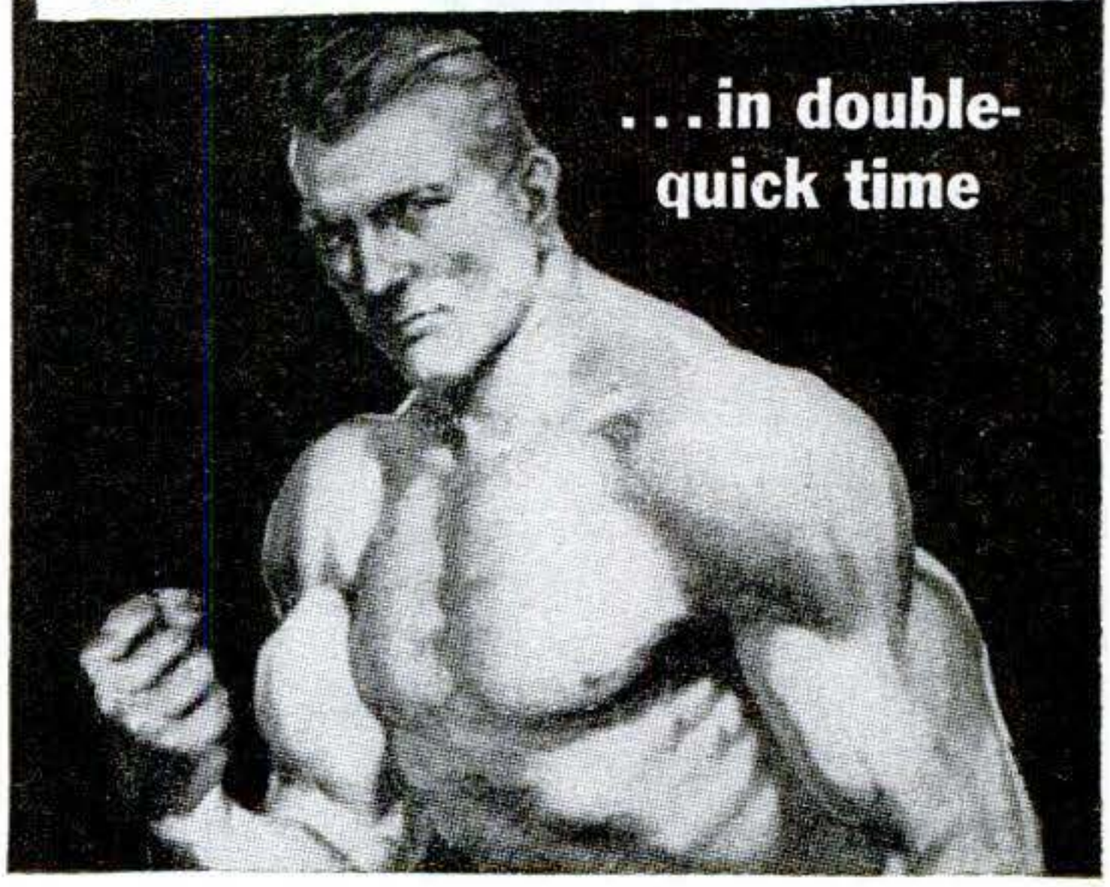

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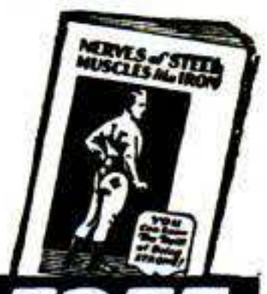

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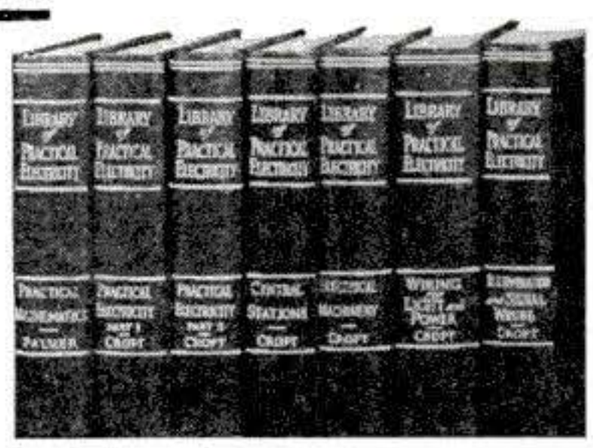

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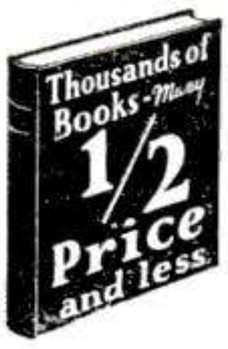

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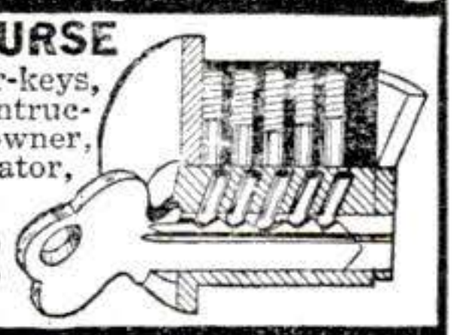

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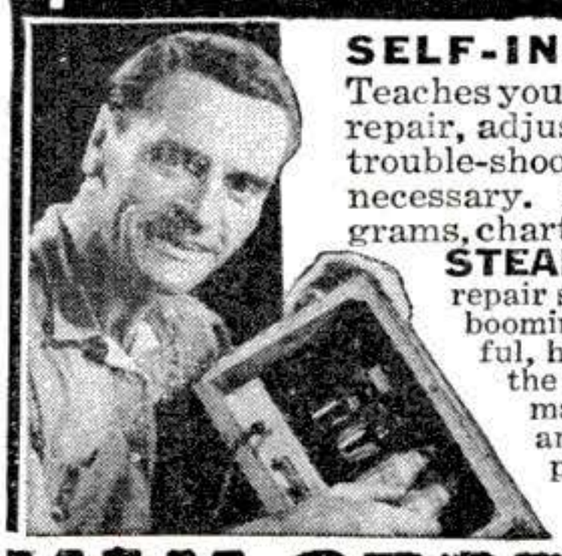

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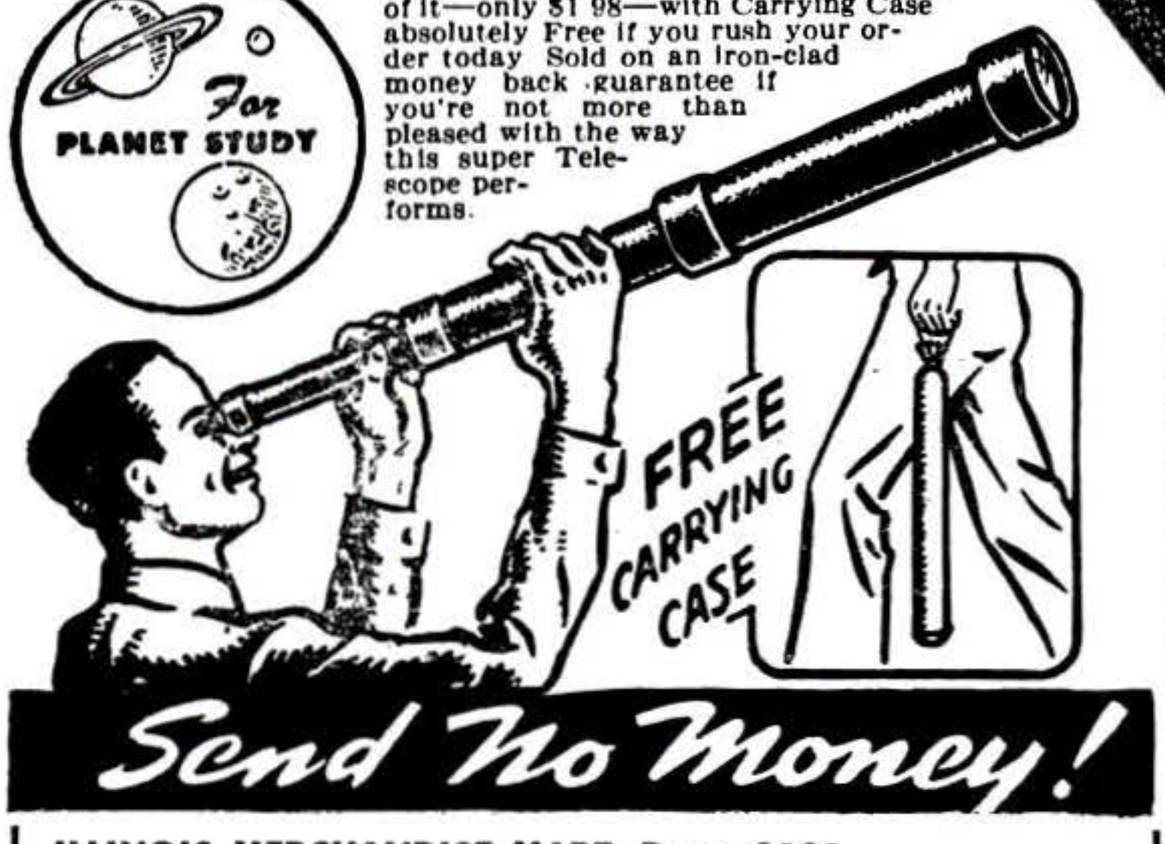

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MAKE unusual spare or full-time profits showing genuine Leather Jackets, Raincoats, 200 Style and Comfort Shoes. Sample Outfit Free. Rush postcard. Mason Shoe Co., Dept. M-192, Chippewa Falls, Wisconsin.

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CALL on Friends with Greeting Card Assortments; Easter, Birthday, other occasions. Personal Stationery; Gift Wrappings. Big profits. Experience unnecessary. Samples on approval. Wallace Brown, 225 Fifth Ave., Dept. N-4, New York 10.

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ANTI-FREEZE, noncorrosive, inexpensive, manufacture yourself. Details for stamp. Betke, Box 699, Borger, Texas.

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FULL size, cut to shape boat patterns, blueprints. 7½—38 feet. Illustrated "Build a Boat" catalog, 10c (coin). "How to Build Boats" book, $1.00. Cleveland Boat Blueprint Co., Station A-77, Cleveland, Ohio.

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OUTBOARDS: Latest bulletin available on rebuilt motors. Good used parts most makes and models. Crandall-Hicks Co., 959 Commonwealth Ave., Boston, Mass.

MAKE 16' Rowboat. Blueprint, 30c. Wee-Sho-You, Box 51, Detroit, Michigan.

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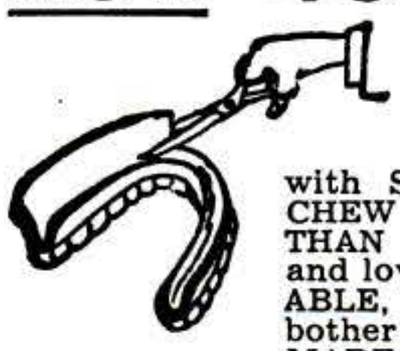

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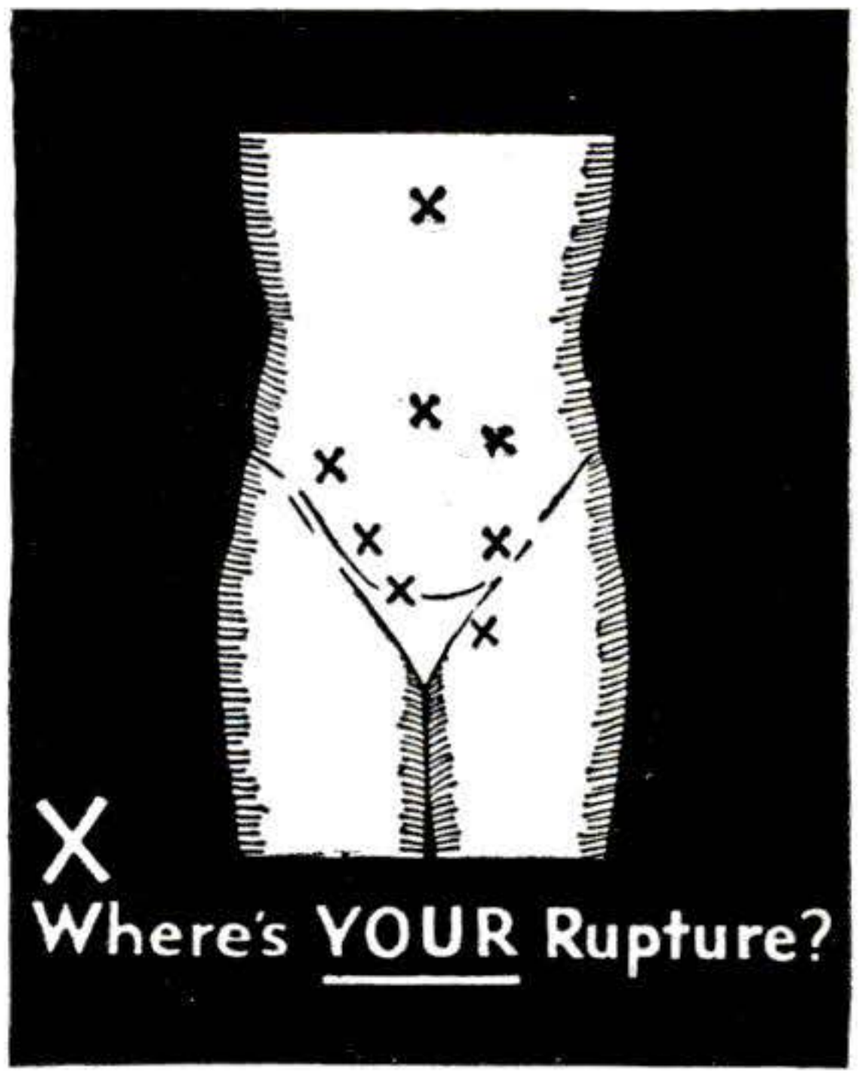

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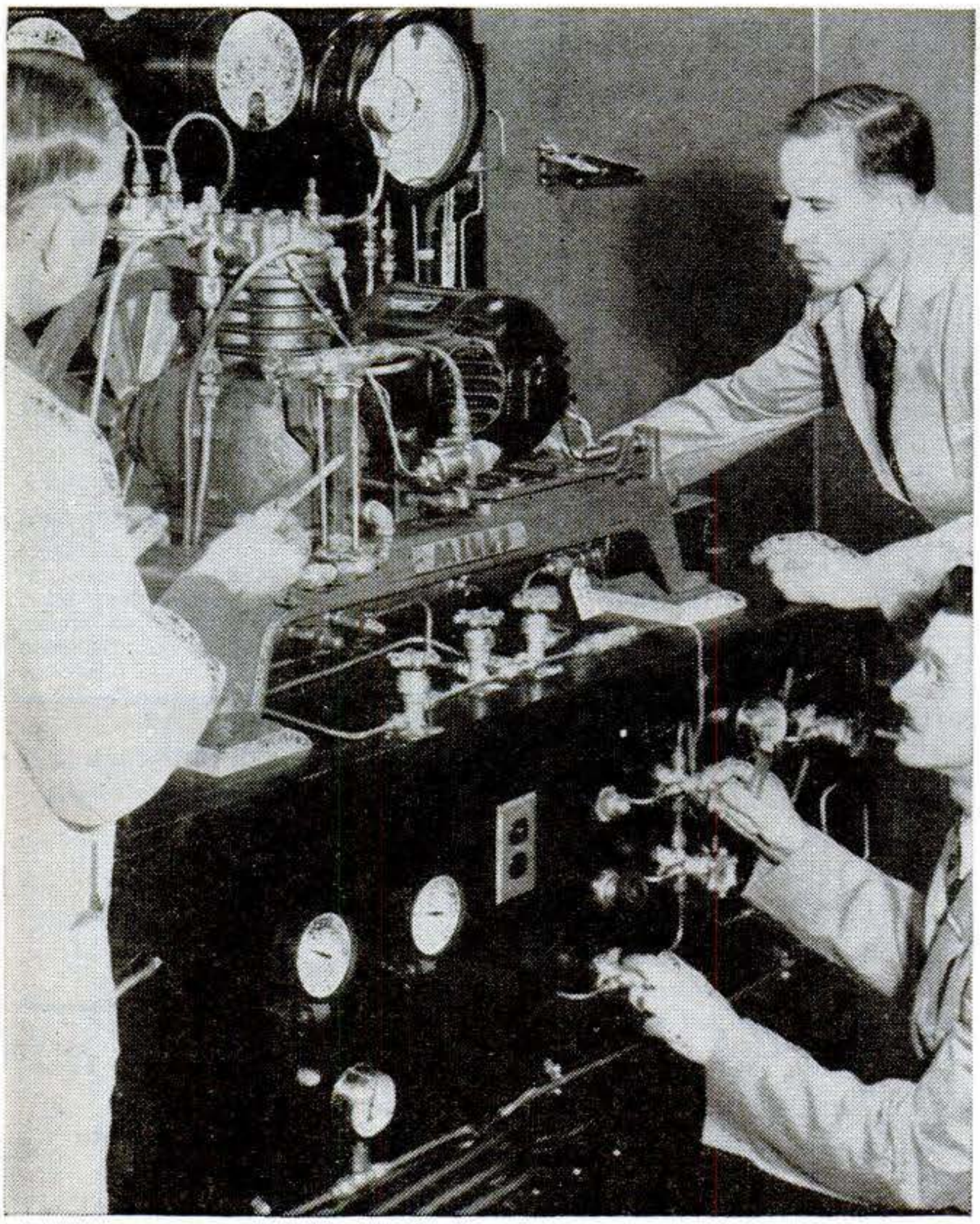

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THE BAZOOKA'S GRANDFATHER

How Prof. Charles E. Munroe's amazing discovery, reported in Popular Science Monthly 45 years ago, is now blasting enemy tanks and fortifications.

By VOLTA TORREY

Drawings by B. G. SEIELSTAD

IN POPULAR SCIENCE MONTHLY, 45 years ago this month, Prof. Charles E. Munroe, of Columbian University (now George Washington University), reported his discovery of some "curious effects produced with explosive substances," for which he thought useful applications might be found. The most startling of those applications were not discovered until after Dr. Munroe's death in 1938; but they are proving extremely useful now, for they are enabling Army Ordnance to design weapons to punch holes in the thick, reinforced concrete and the heavy armor plate behind which our besieged enemies lurk.

The "Munroe effect" is the secret within many secret weapons, and its utilization is one of the most important scientific developments in the field of explosives during this war. It gave the bazooka its terrific wallop. And it is being used to bore into the very foundations of the fortifications, pillboxes, bridges, and other installations of the Germans and Japanese.

Dr. Munroe, who also helped develop smokeless powder, noticed this highly important peculiarity of explosives while working at the Naval Torpedo Station at

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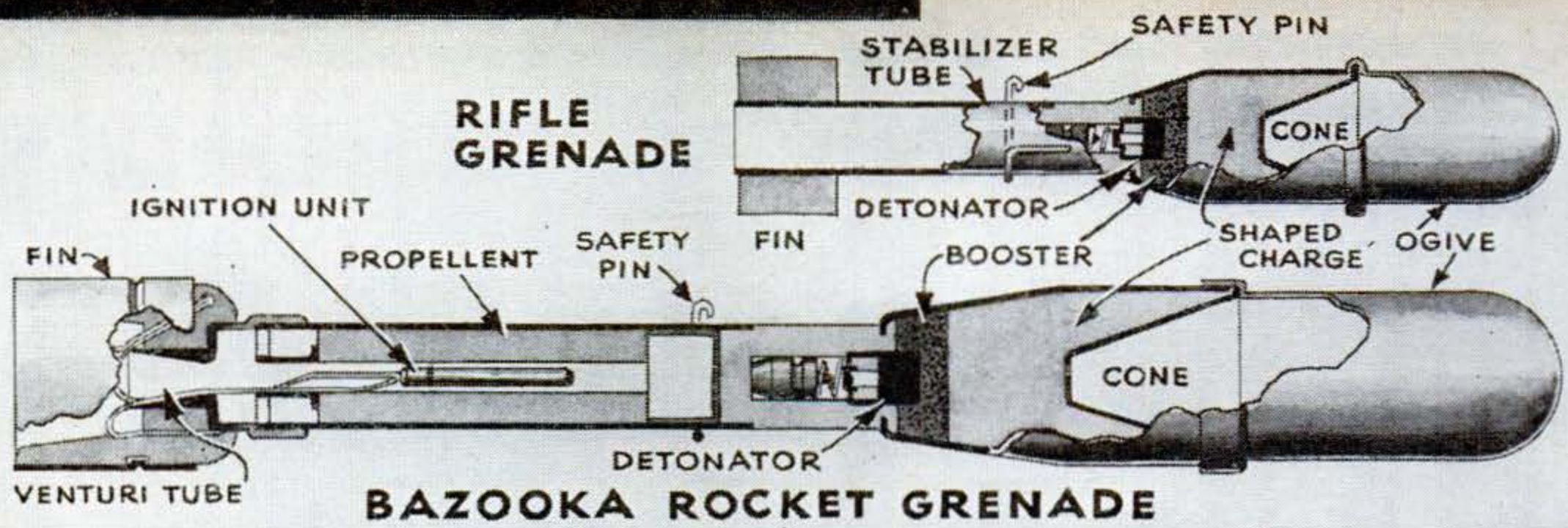

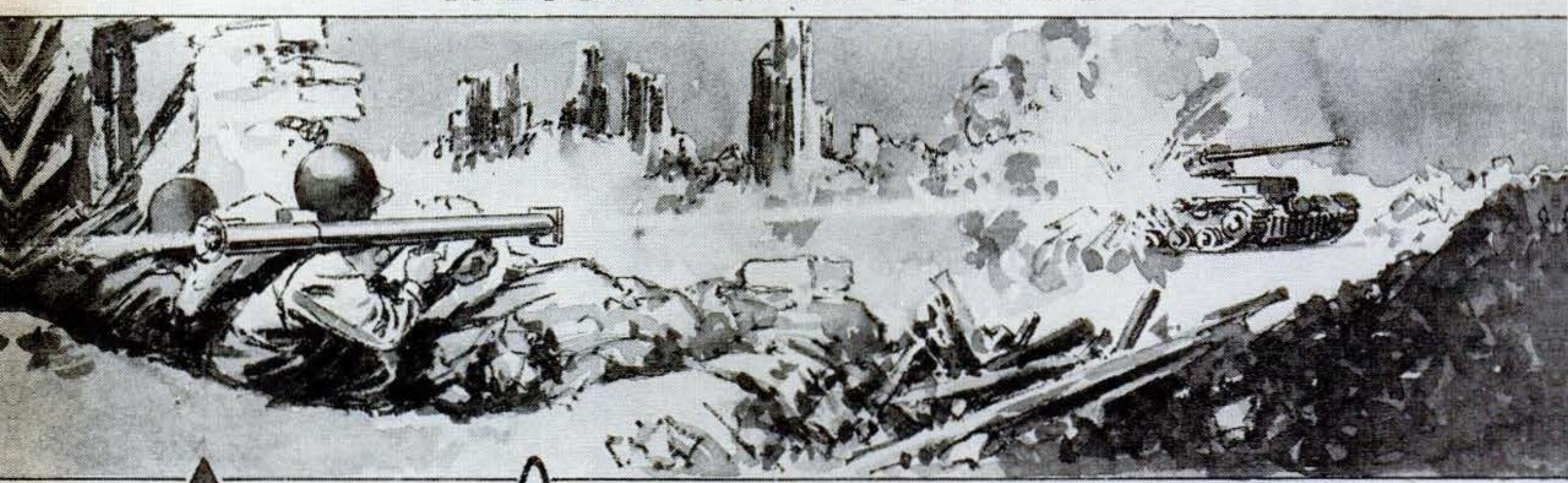

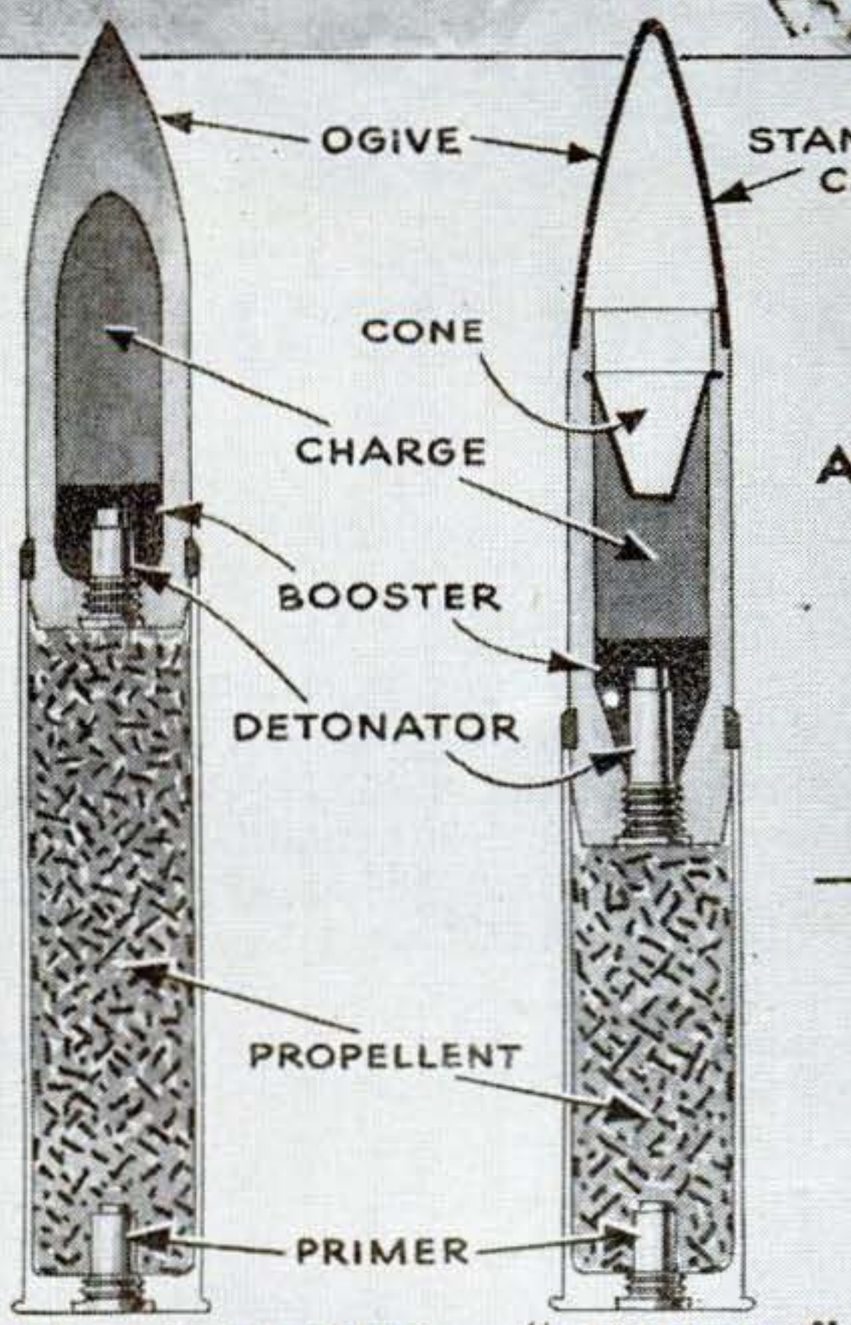

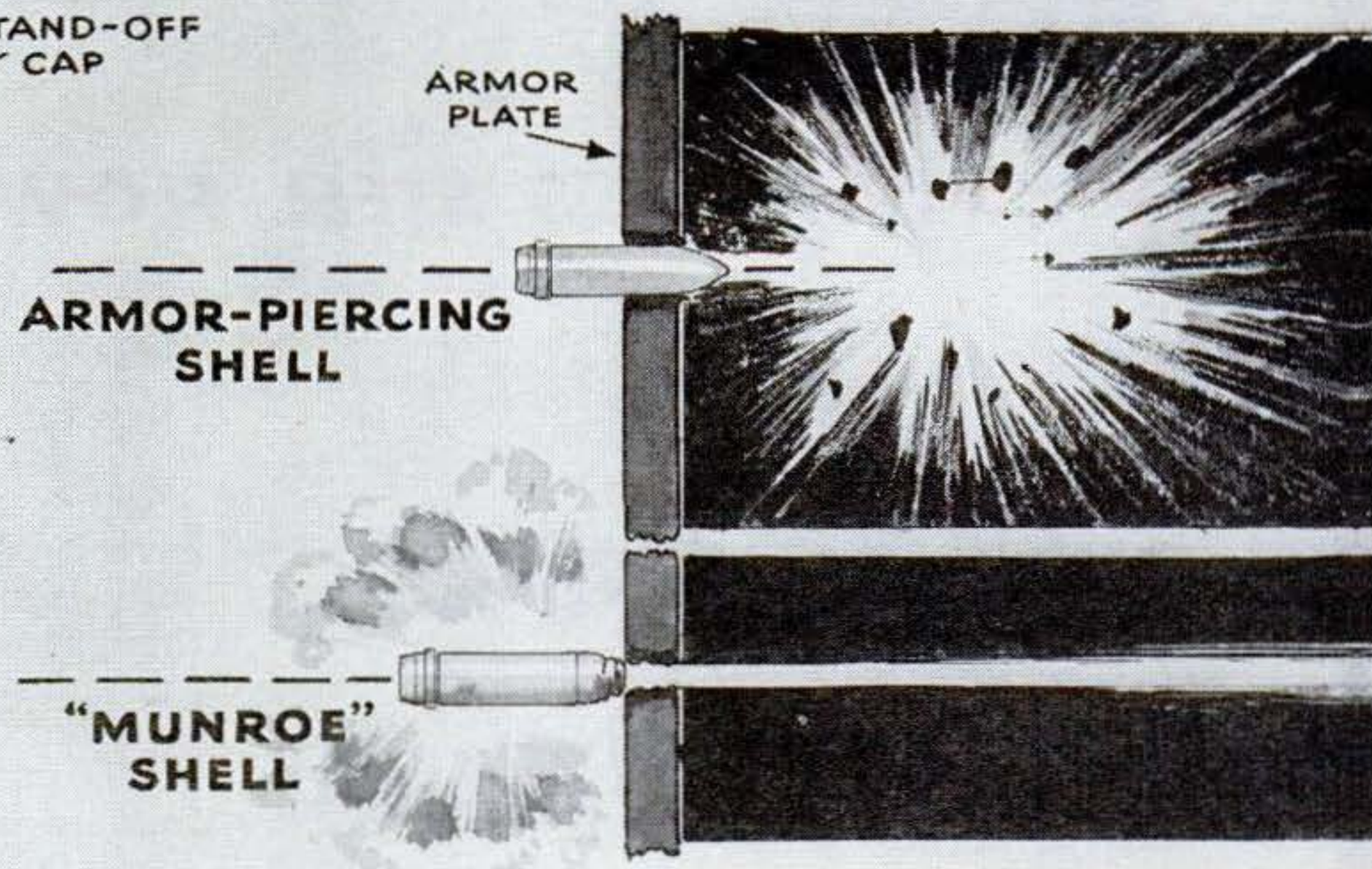

MUNROE AND STANDARD-TYPE ARMOR-PIERCING ARTILLERY AMMUNITION
(STRAIGHT 105-MM. CASES USED FOR COMPARISON)

Newport, R. I., back in the 1880's. When guncotton was molded there, holes were bored in each cylinder for the insertion of a detonator. Letters and figures were also stamped in the cakes of explosive. And, in the course of his work, Dr. Munroe found that when a block thus punched or indented was placed on an iron plate and exploded, indentations corresponding to those in the explosive were made in the plate.

Experimentally, he placed leaves, bits of lace, coins, and stencils between the gunpowder and the metal plates and succeeded in producing raised ornamental designs on the surface of the plates by setting off the explosive. Experimentally, too, he put sticks of dynamite around a tin can, thus creating a cavity in the middle of a charge—and found that he then could blow a hole in the side of a heavy steel safe with much less

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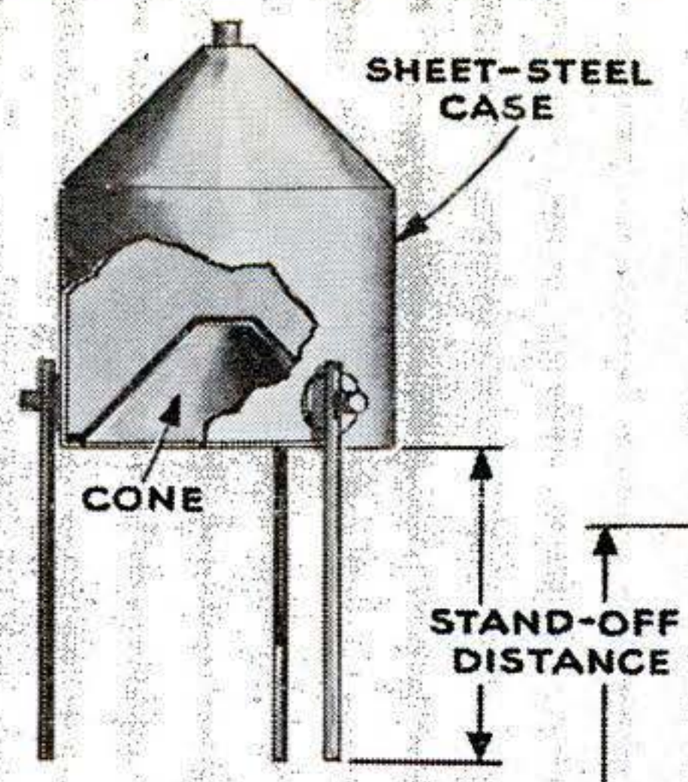
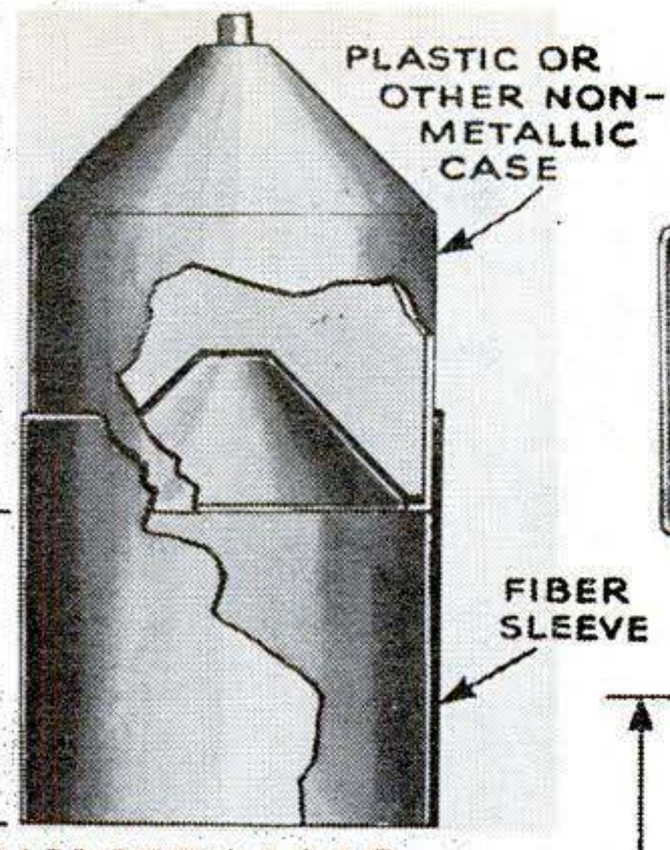
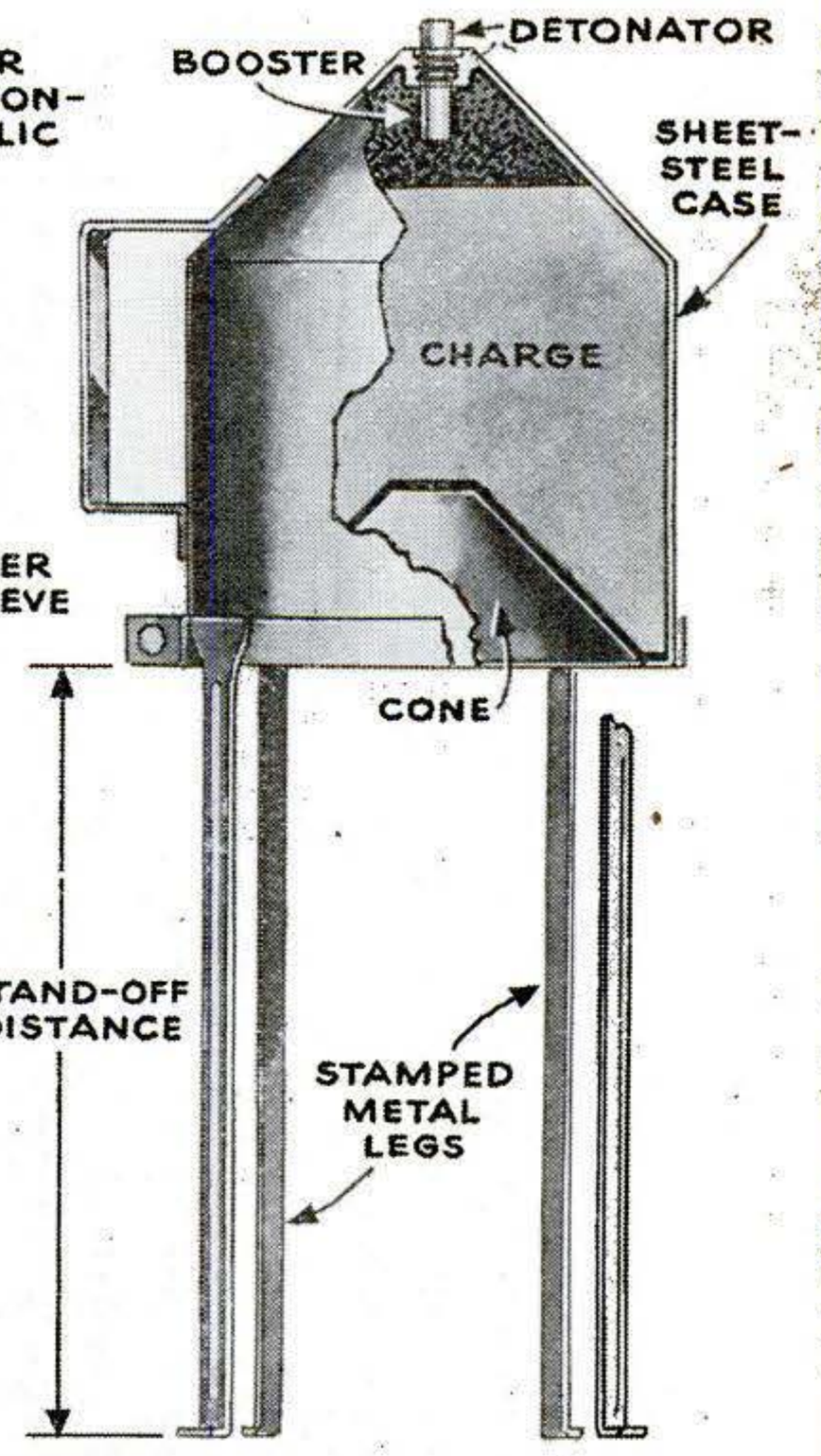
PLACED DEMOLITION CHARGES



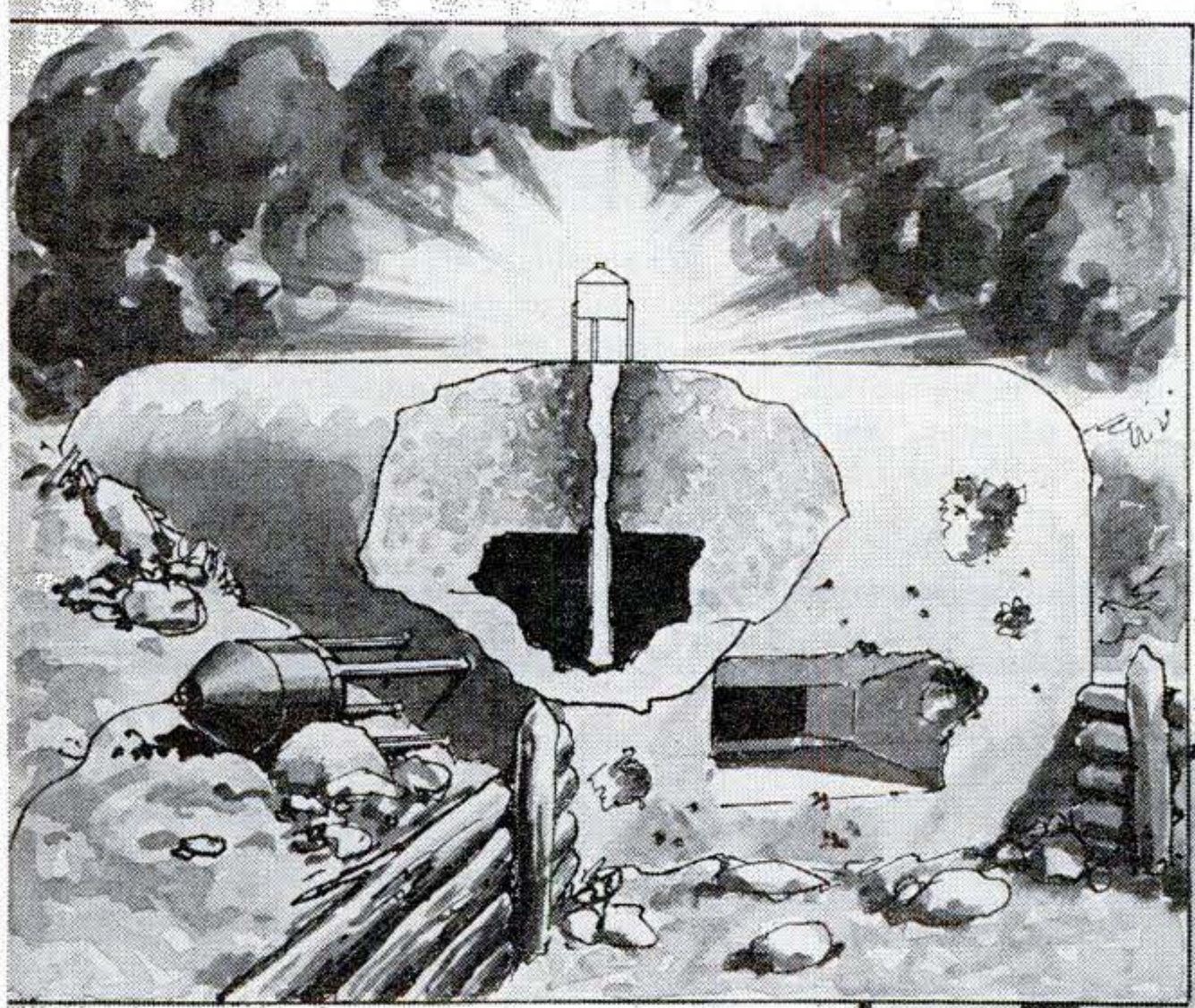
SMALL



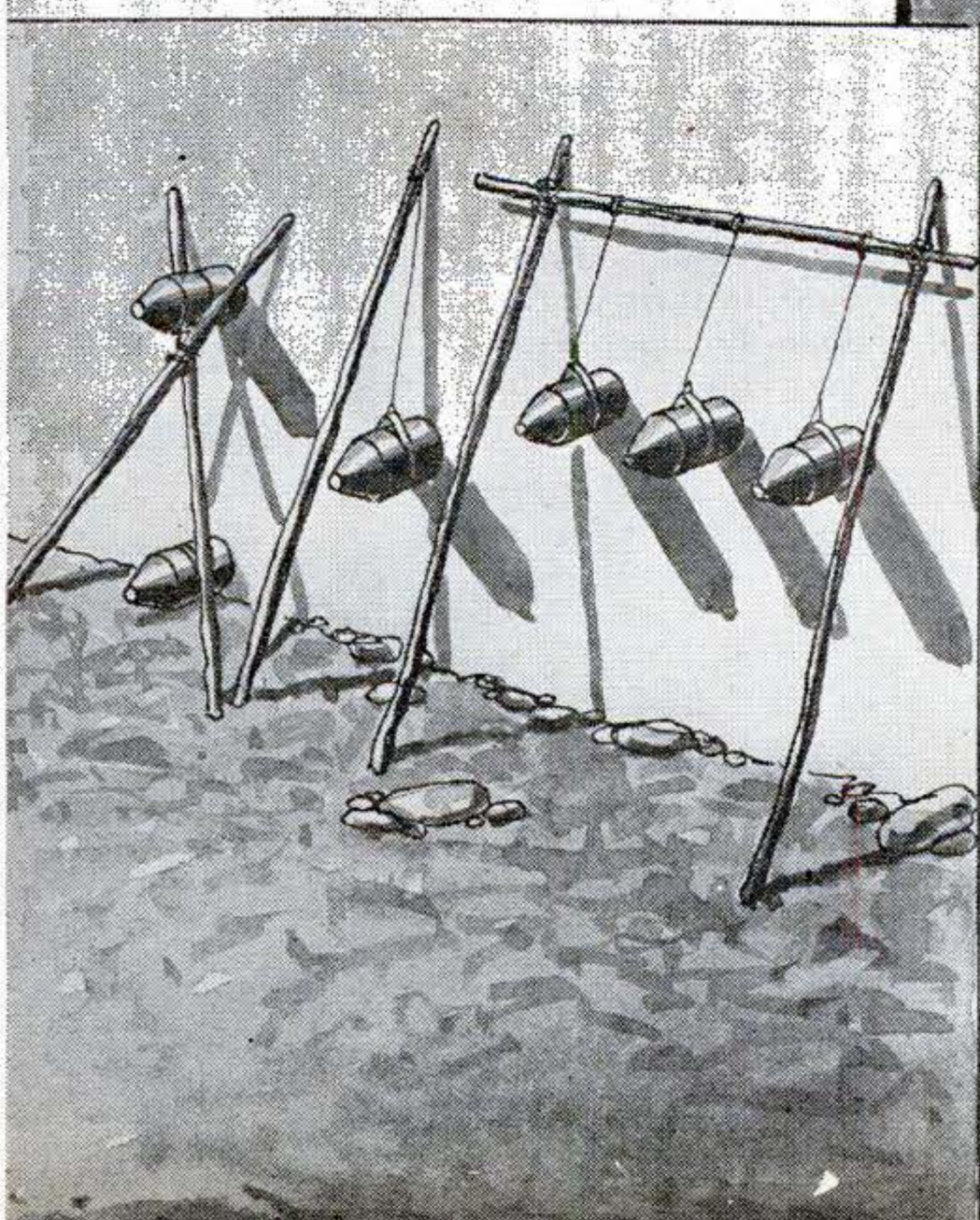
NONMETALLIC

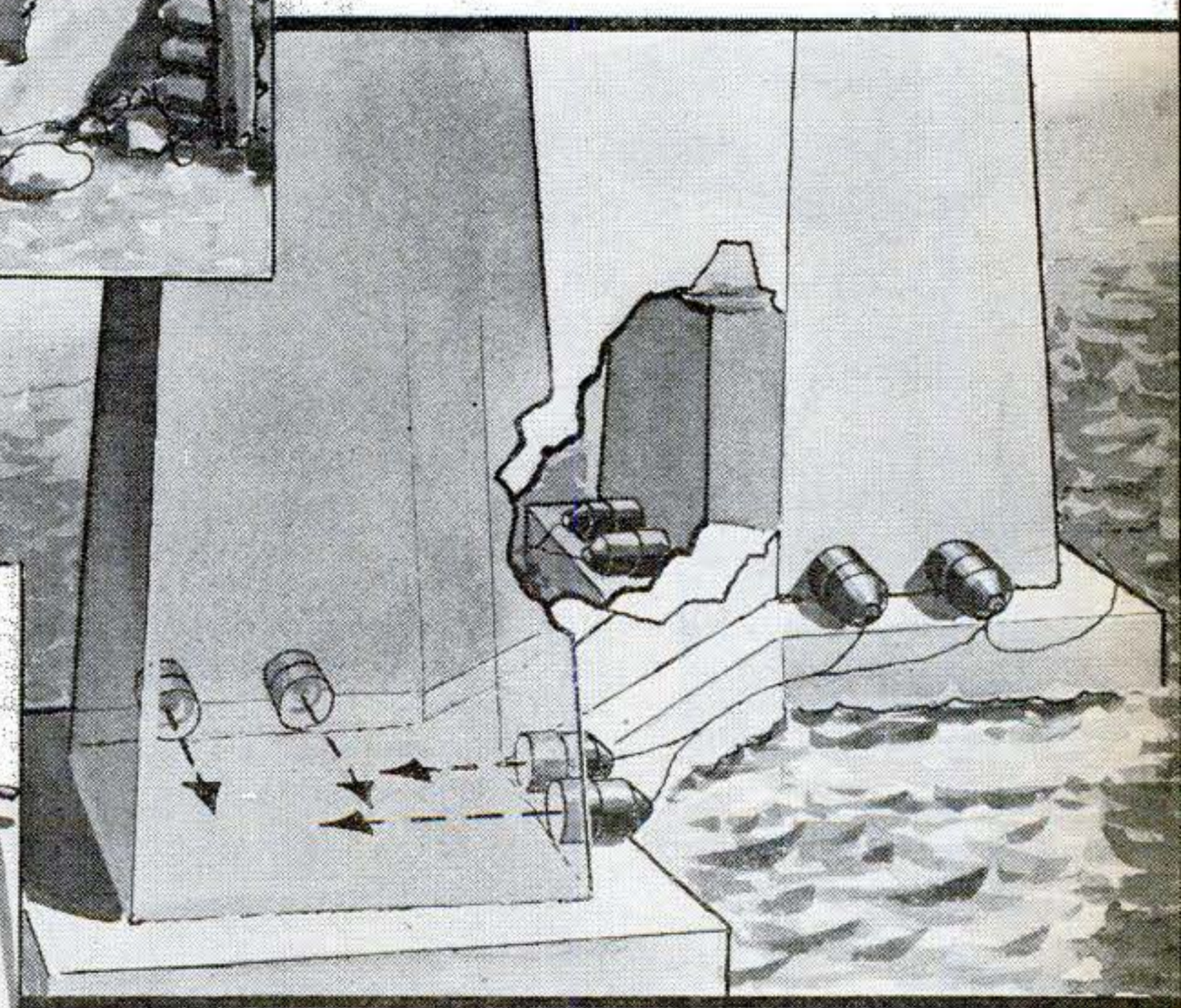


LARGE



SMALL TYPE ON TOP—LARGE AT SIDE—BOTH USED ACCORDING TO NEEDS





NONMETALLIC TYPE USED TO FORM "BLOW HOLES" FOR PLACING DEMOLITION CHARGES IN BRIDGE PIERS

THREE METHODS OF PLACING CHARGES AGAINST OBJECT TO BE BLASTED

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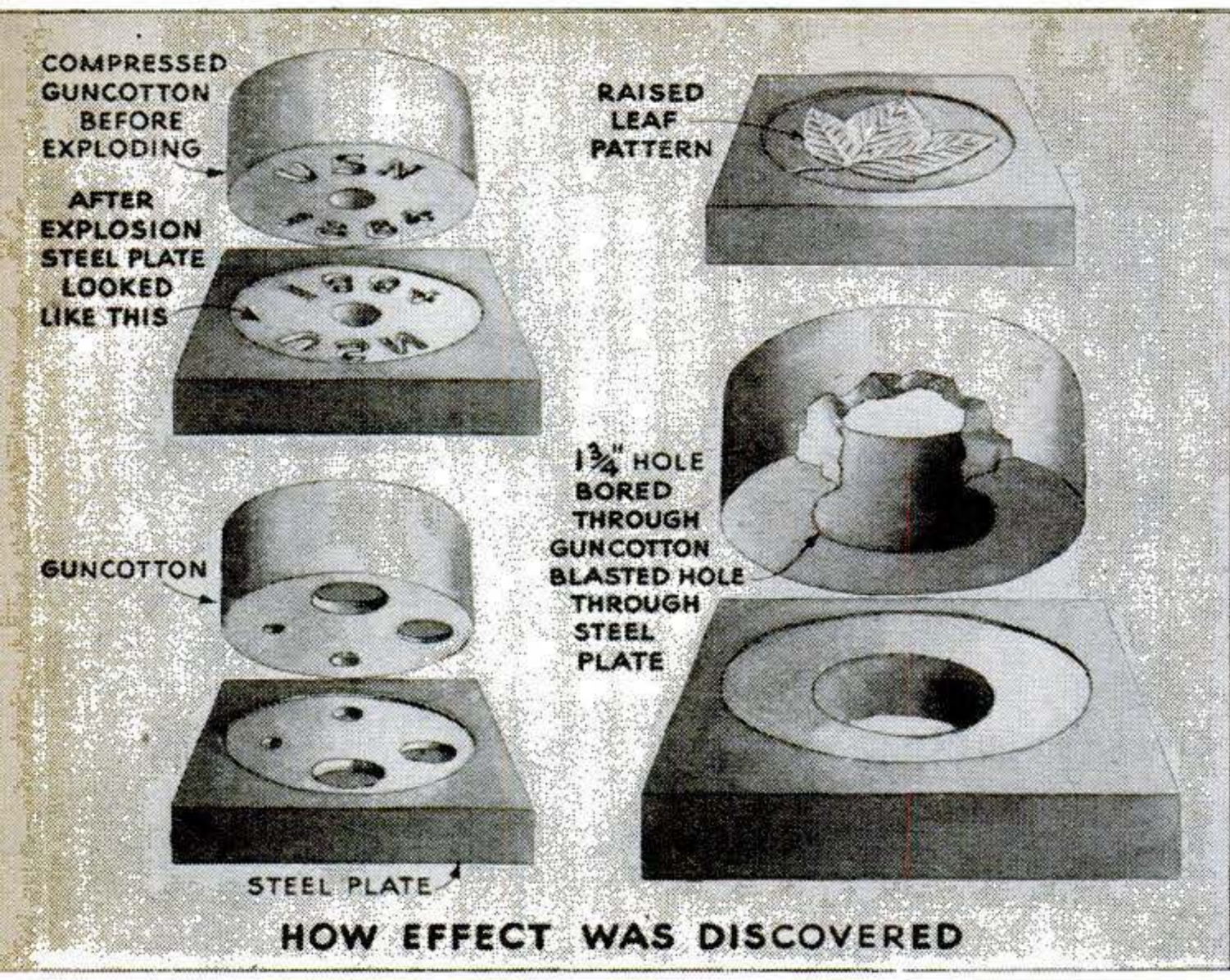
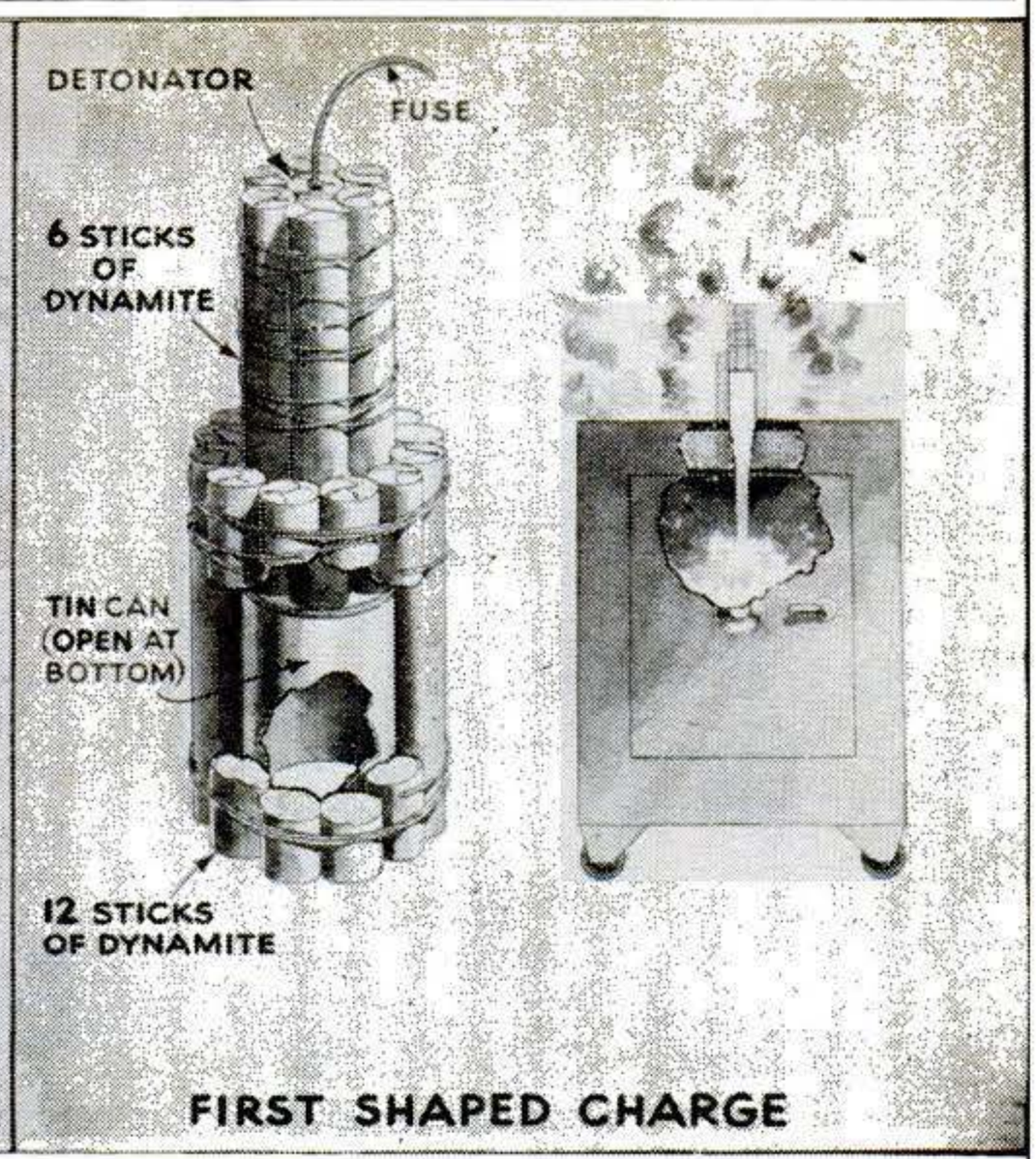
DR. MUNROE'S EARLY EXPERIMENTS (POPULAR SCIENCE, FEB. 1900)



HOW EFFECT WAS DISCOVERED

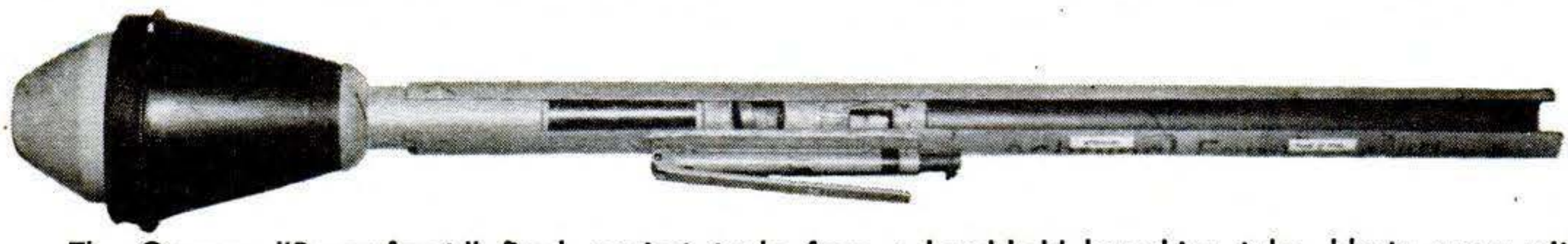


FIRST SHAPED CHARGE

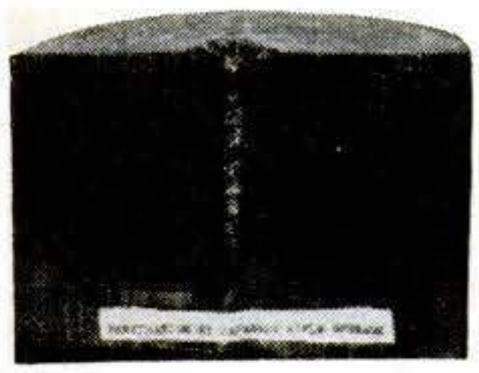
While testing explosives at the Newport, R. I., Naval Torpedo Station, Dr. Munroe noticed that cavities in blocks of guncotton were reproduced on iron plates on which the explosive was test-fired. Leaves placed under the guncotton were reproduced as raised patterns. These drawings were made from photos published in Popular Science 45 years ago

When this crude hollow charge was exploded on top of a heavy steel safe, it blew a three-inch hole in the 4¾-inch wall. The same amount of dynamite, arranged as a solid charge, had practically no effect on the steel safe wall

OUR ENEMIES ALSO USE HOLLOW-CHARGE WEAPONS

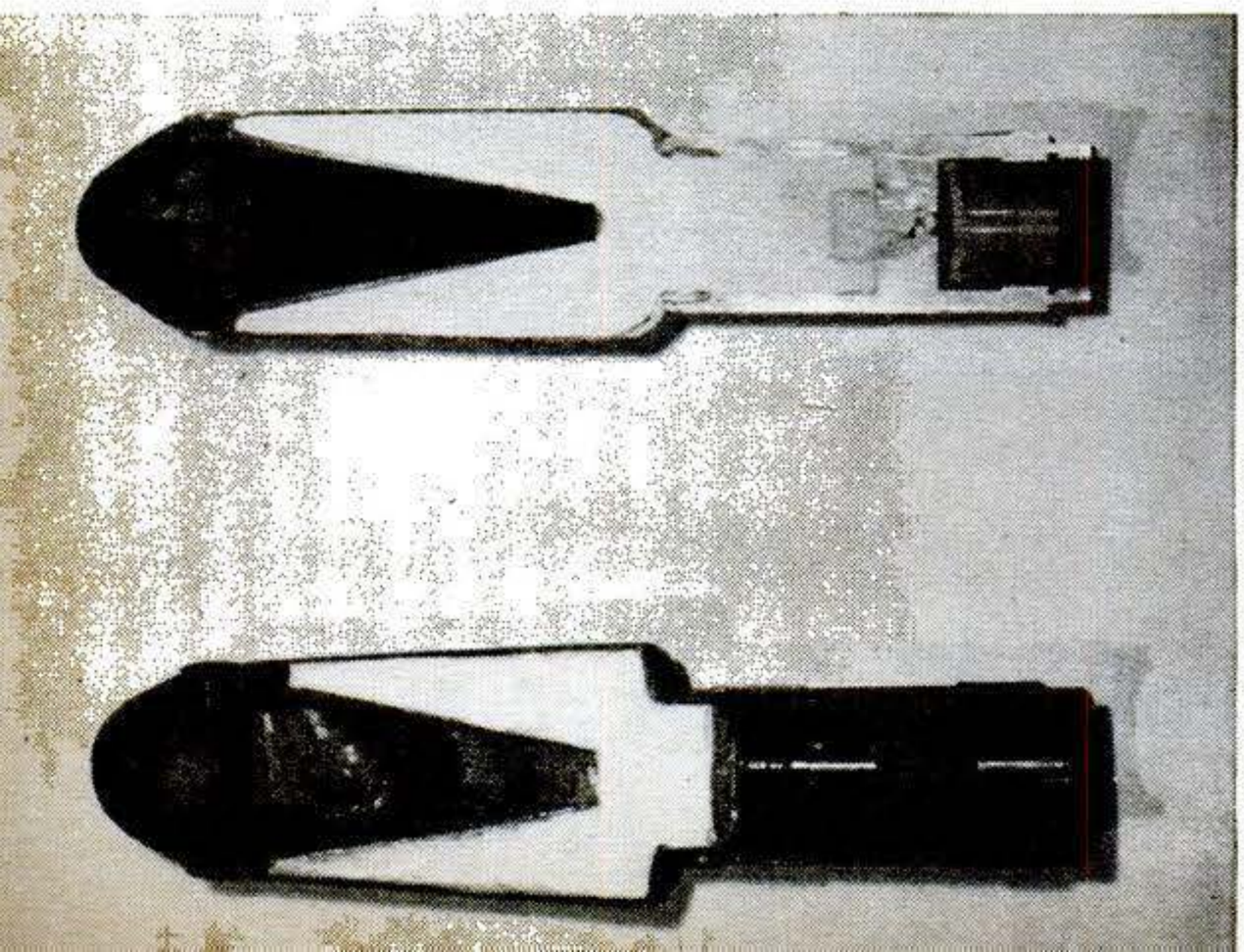


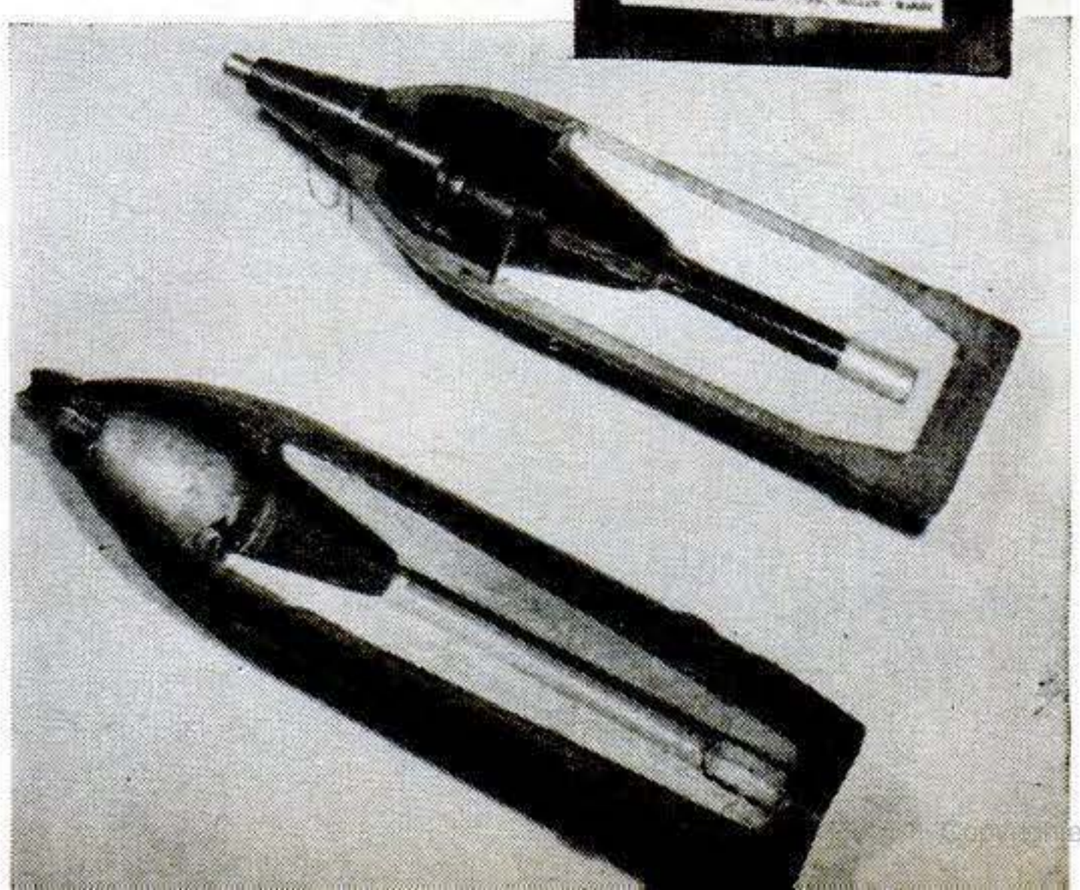
The German "Panzerfaust," fired against tanks from a hand-held launching tube, blasts armor with a conical charge 5.87 inches in diameter. This is not a rocket weapon; it is propelled by a cartridge in the launching tube, which is nearly a yard long. A folding sight enables it to be aimed with some accuracy



Below are a Jap hollow-charge rifle grenade (top) and German weapon from which it was copied. At left is a block of mild steel (not armor plate), showing a hole 3½ inches deep blown in it by the Jap grenade. Japs put fins on this grenade and drop it in clusters from planes

Jap (top) and German 75-mm. hollow-charge artillery shells. Our ordnance experts say the Jap job is a poor copy. The Nazi shell tore a hole 6¾ inches deep in the billet of mild steel at right, in tests at Aberdeen Proving Ground





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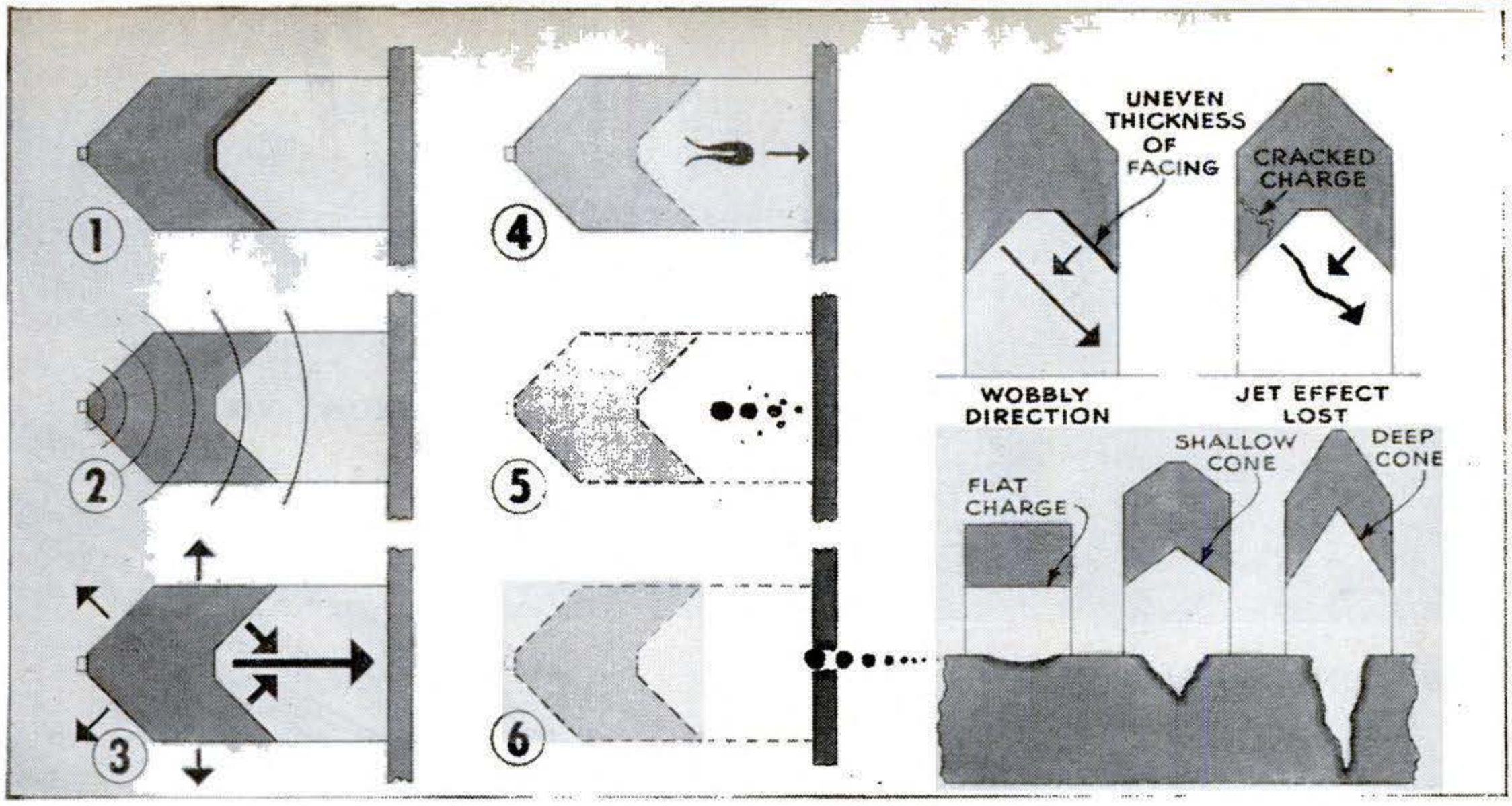

Explosion of hollow charge (1) creates detonation waves (2). In hollowed-out portion, force is concentrated to form a jet (3)

Metal torn off the cavity lining is turned inside out (4) or forms pellets (5) that join the jet to plow through armor (6)

Imperfections in the hollow charge may reduce its effectiveness, as seen in the upper drawings. Shape of the charge is varied to suit the target and the kind of effect that it is designed to produce

dynamite than would be needed if the whole charge were placed flat against the wall of the safe.

Dr. Munroe, in short, found a way to concentrate a portion of the force of an explosion on a particular spot. And that way, which seemed curious even to him, consists of leaving a cavity in the explosive at the very spot where the maximum force is desired. The British now call the Munroe effect "the cavity effect of explosives," and American experts often describe the blocks of explosives in which this effect is now used as "hollow" or "shaped" charges.

A Norwegian investigator had suggested much earlier that air space might be used to enhance an explosive's effect. The idea was taken to Germany in the 19th century, and applied in the mines in the Saar region, but did not catch on among German military men. A patent on an application of the idea was issued in Germany in 1910, and another patent was issued in Britain in 1911, but no nation did much with the idea during World War I. Interest in Dr. Munroe's principle was revived, however, a few years ago, and his work now has been continued by the Research and Development Service of the U. S. Army Ordnance Department with many remarkable results.

The Munroe effect may be obtained with any kind of high explosive by cutting a cavity of almost any size or shape in the side of the charge that is placed toward the object to be cut or punctured. Miners have been known to arrange sticks of dynamite in the shape of a tepee to blow a hole in the ground. And demolition engineers sometimes have taken a jackknife and cut a little chunk out of a block of dynamite before placing it against an object to be severed.

But, to attain the full benefit of the Munroe effect, the cavity must be shaped scientifically, a lining of the correct kind of material must be placed in this cavity, the charge must be held a certain distance from the object against which its force is to be directed, and the detonation of the explosive substance should begin at its rear. No simple rule is known yet by which the effectiveness of certain size or shape of cavity in different weights, shapes, and varieties of explosive charges can be predicted. By dint of much research, however, the Ordnance Department has provided our Army with a wide variety of hollow charges that can be counted on to produce definite results.

U. S. Army engineers, for example, use demolition charges that look like thick, stubby cones. These are placed in light metal cans, or even more fragile containers, with legs or rims to hold the large end of the cone a suitable distance from the surface to be hit with the maximum explosive force. The charge is then detonated from the opposite, or pointed, end of the cone.

When it is touched off, a detonation wave races through the explosive substance. This is a chemico-physical wave that progresses from layer to layer of molecules, causing them to vibrate *(Continued on page 211)*

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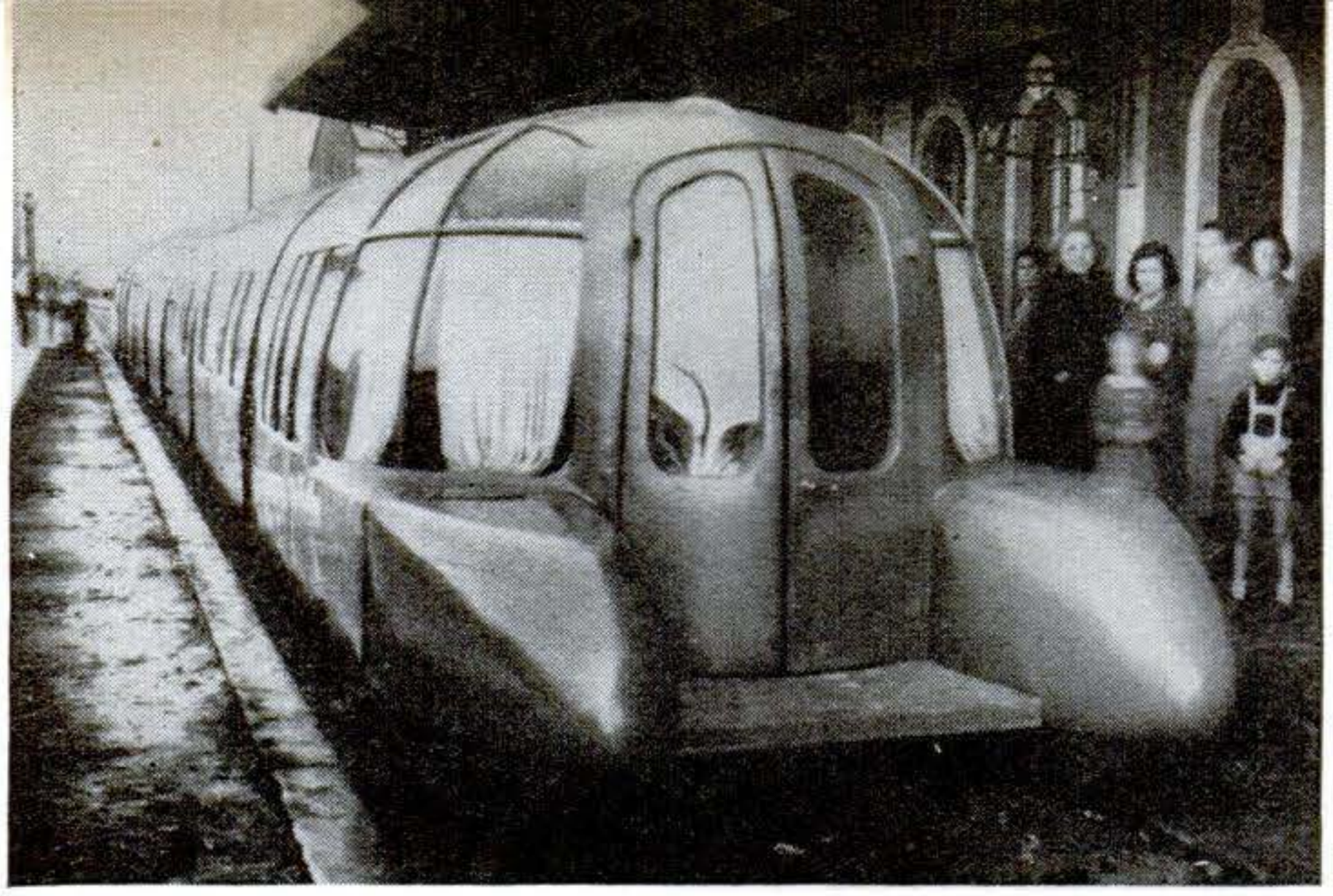
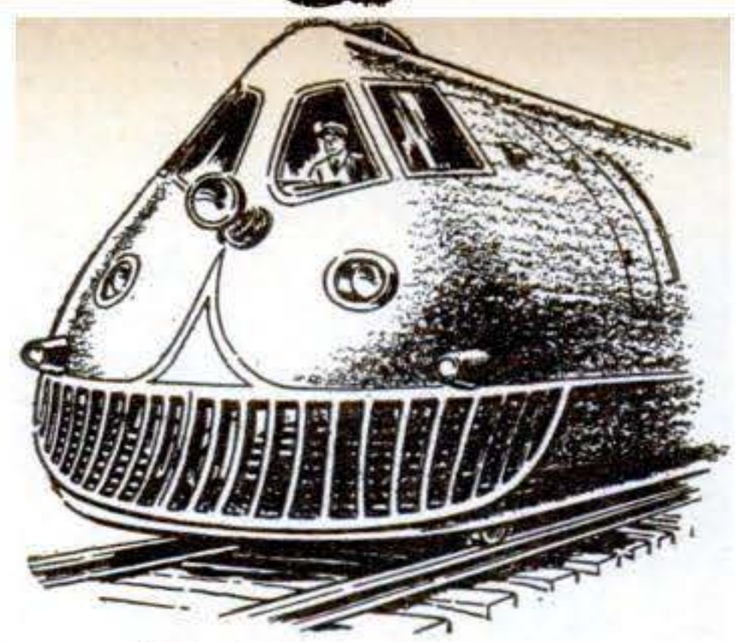
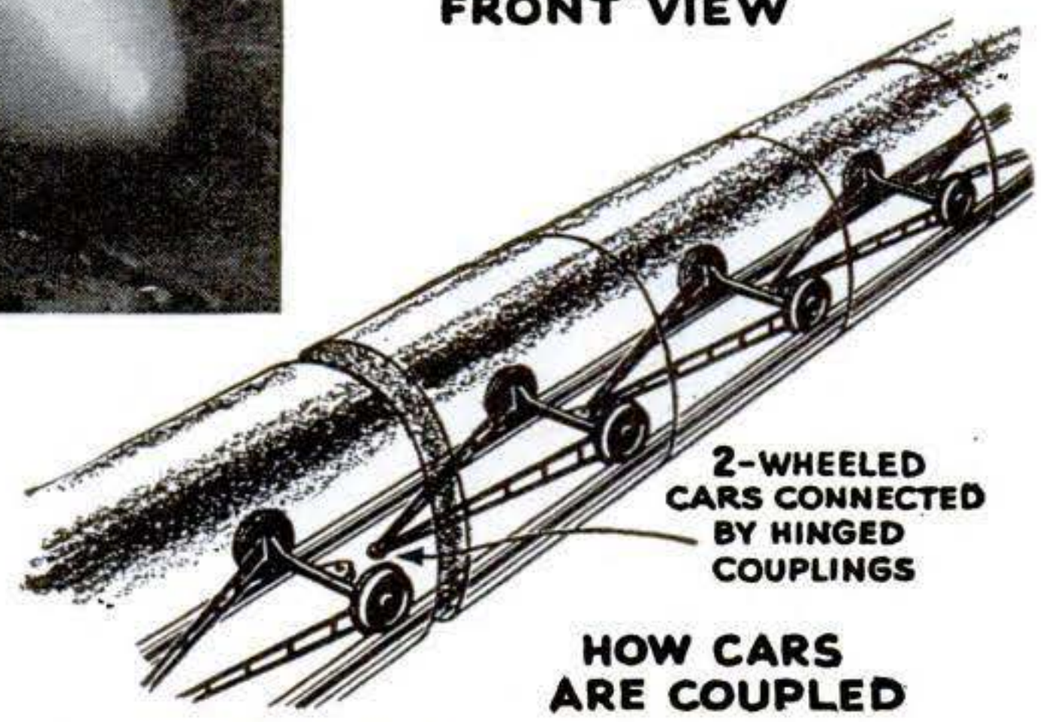




FRONT VIEW



HOW CARS ARE COUPLED

LOW-SLUNG TRAIN TRAVELS FAST. This new Spanish railroad train, light, streamlined, and Diesel-powered, makes 105 miles an hour on the straightaway, but slows down for mountain curves to a mere 80 m.p.h. Ordinary trains take curves at 30 or thereabouts. The inventor, Alejandro Goicoechea, placed the center of gravity only half as high as usual, thereby making it possible for the cars to hold the rails in spite of greatly reduced weight. Axles have been eliminated; there are two separately suspended wheels at the rear of each car, while the front end is linked to the preceding car.

WELDED-STEEL CRUISER, known as Steelcraft, is a late development in the production of pleasure boats. The hull is fabricated from only seven pieces, welded and completely stress-relieved. The V-type bottom is formed of two pieces, the sides of two more, and there is one piece each for the deck, chine, and transom. The normal equipment is an 85-hp. motor. The builders of Steelcraft are Churchward & Co. of West Haven, Conn.

WEIGHTED REVOLVER aids Capt. E. W. Strother, Assistant Chief of Staff of the Seventh Naval District, to maintain his skill as a pistol shot while practicing indoors. He attaches weights totaling six pounds to the butt and trigger guard of his unloaded pistol, and pulls the trigger to the beat of a metronome. Eye and muscle control are kept at concert pitch, for unless he holds his arm steady, the weights swing like pendulums and indicate what would probably be a wild shot if he were shooting with a loaded weapon.

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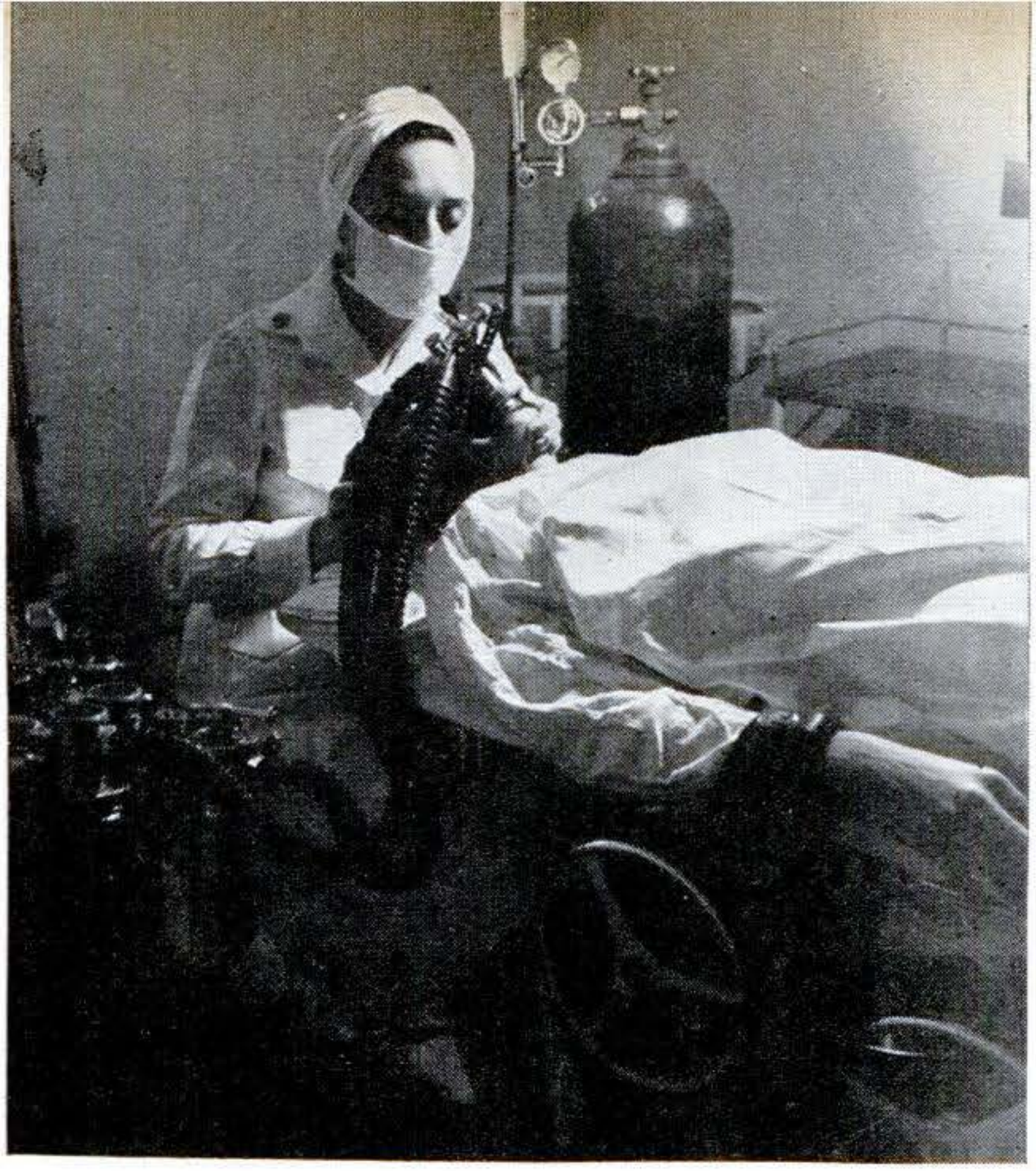
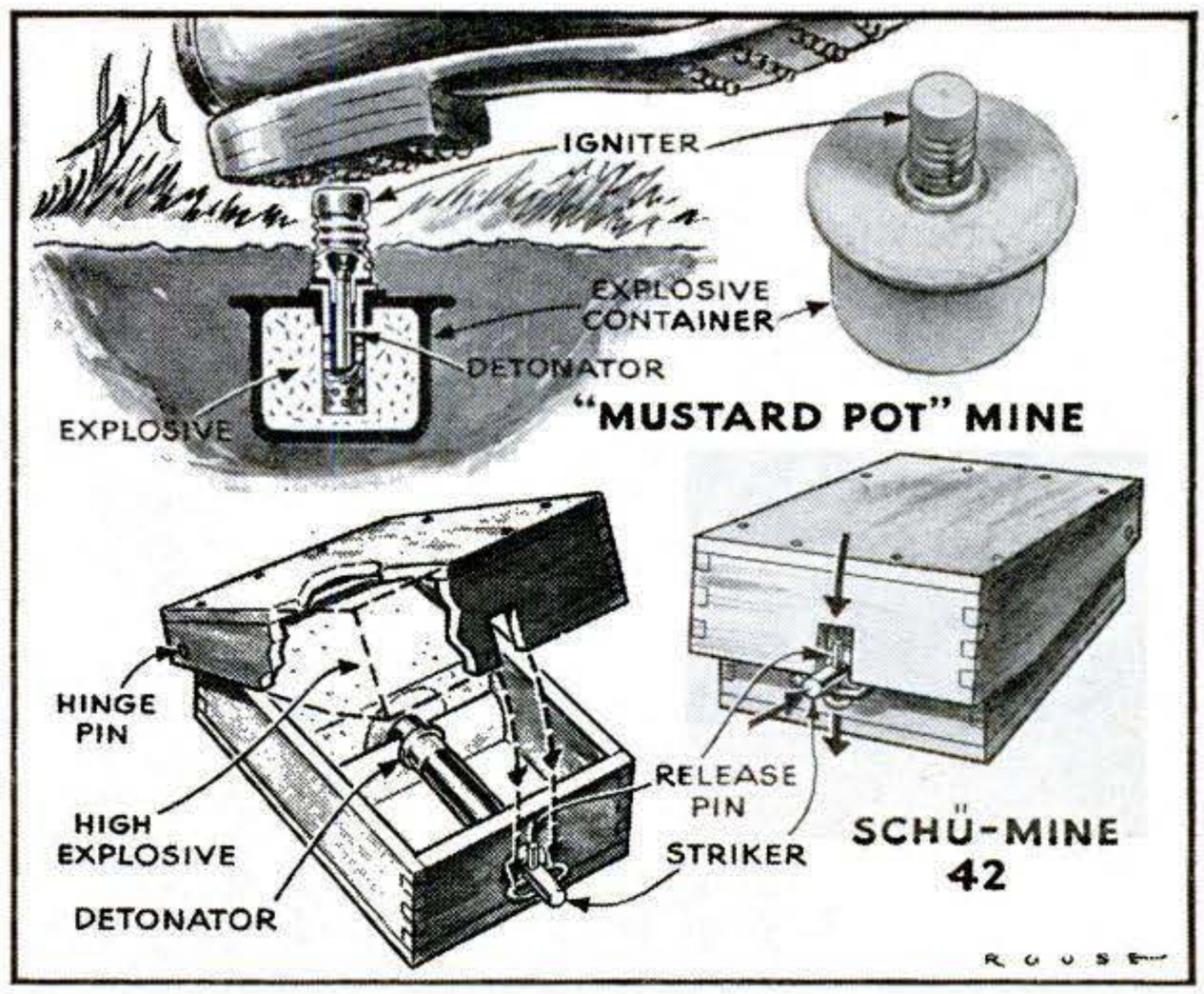


THE NAVY needs trained nurses—at least 2,000 more by June 30. The need is urgent. Registered nurses, between 21 and 40, who are graduates of accredited schools of nursing, who have been citizens for 10 years, and who are single or legally separated, may apply for commissions in the Navy Nurse Corps. Application blanks and additional information may be had from The Surgeon General of the U. S. Navy, Bureau of Medicine and Surgery, Navy Department, Washington 25, D. C.

HEAD-WOUND GAS MASK developed by Chemical Warfare Service at the Massachusetts Institute of Technology will protect fighters with bandaged heads, faces, or jaws against poison gas. It consists of a silklike, translucent vinylite hood to which an air-purifying canister and outlet valve are attached to allow for ordinary breathing. There is a semiflexible transparent vinylite window to insure clear vision for the wearer. The mask is easily compressed, and an oblong waterproof plastic sack is provided for carrying.



ANTIPERSONNEL MINES used by the Germans include the "mustard pot" and the "schü-mine," both of which explode at slight pressure. The mustard pot, so nicknamed by the Yanks because of the color it is painted, weighs 13 ounces, measures 3½ inches in height by three inches in diameter, and is fairly easy to locate with mine detectors, though more difficult by probing. The schü-mine, set off by the tread of a shoe, is hard to locate with metallic detectors, owing to its small metal content. The casing, which includes the box and the free-moving lid, is made of impregnated plywood. It is laid so that the igniter points away from the enemy and the top of the lid should be level with the surface of the ground. If there is sufficient vegetation for concealment, it may even be laid on top of the ground.

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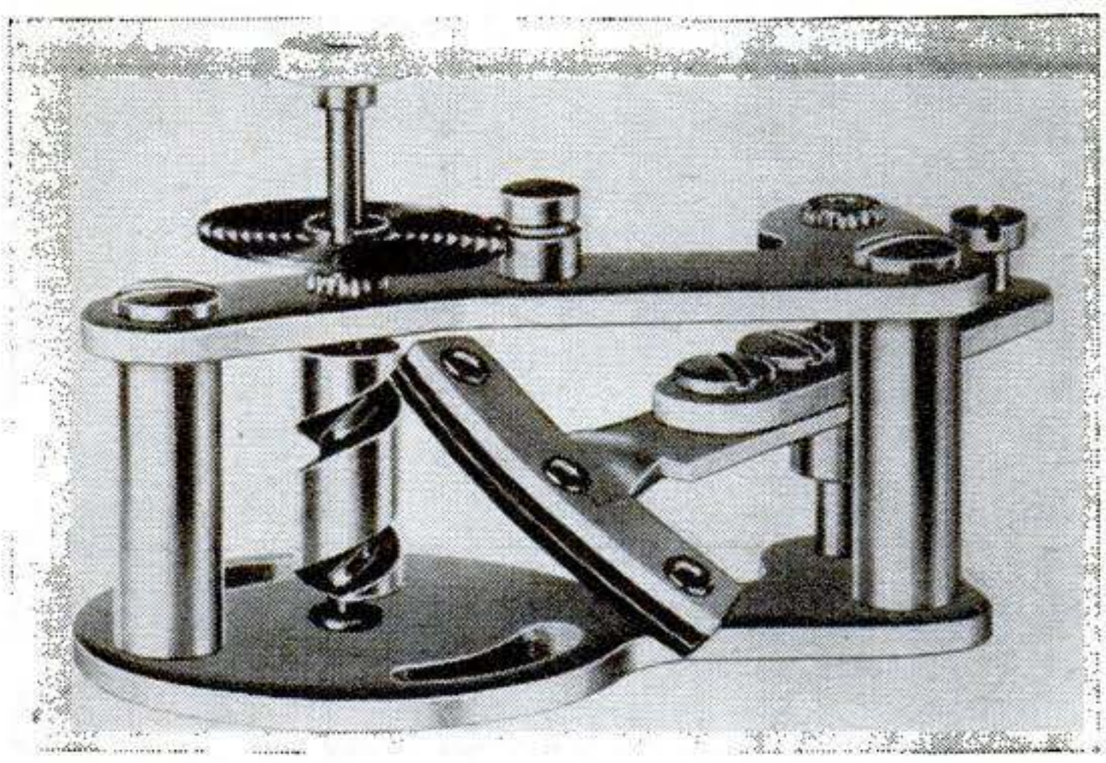
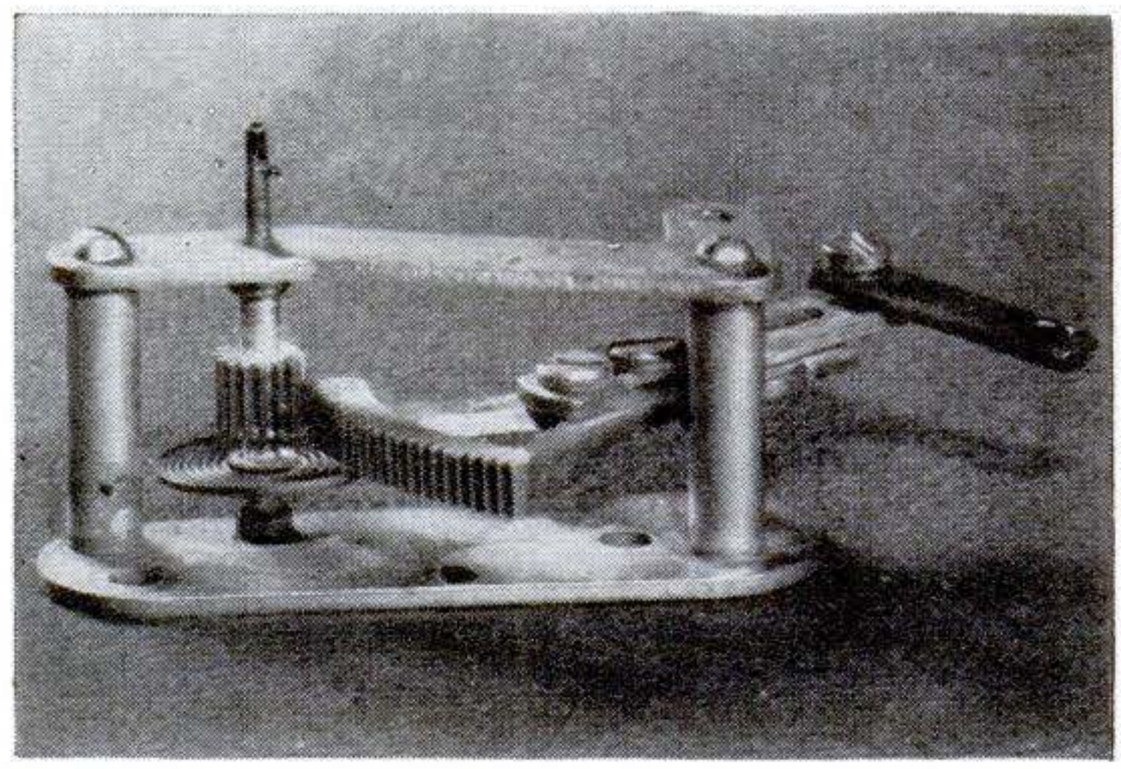
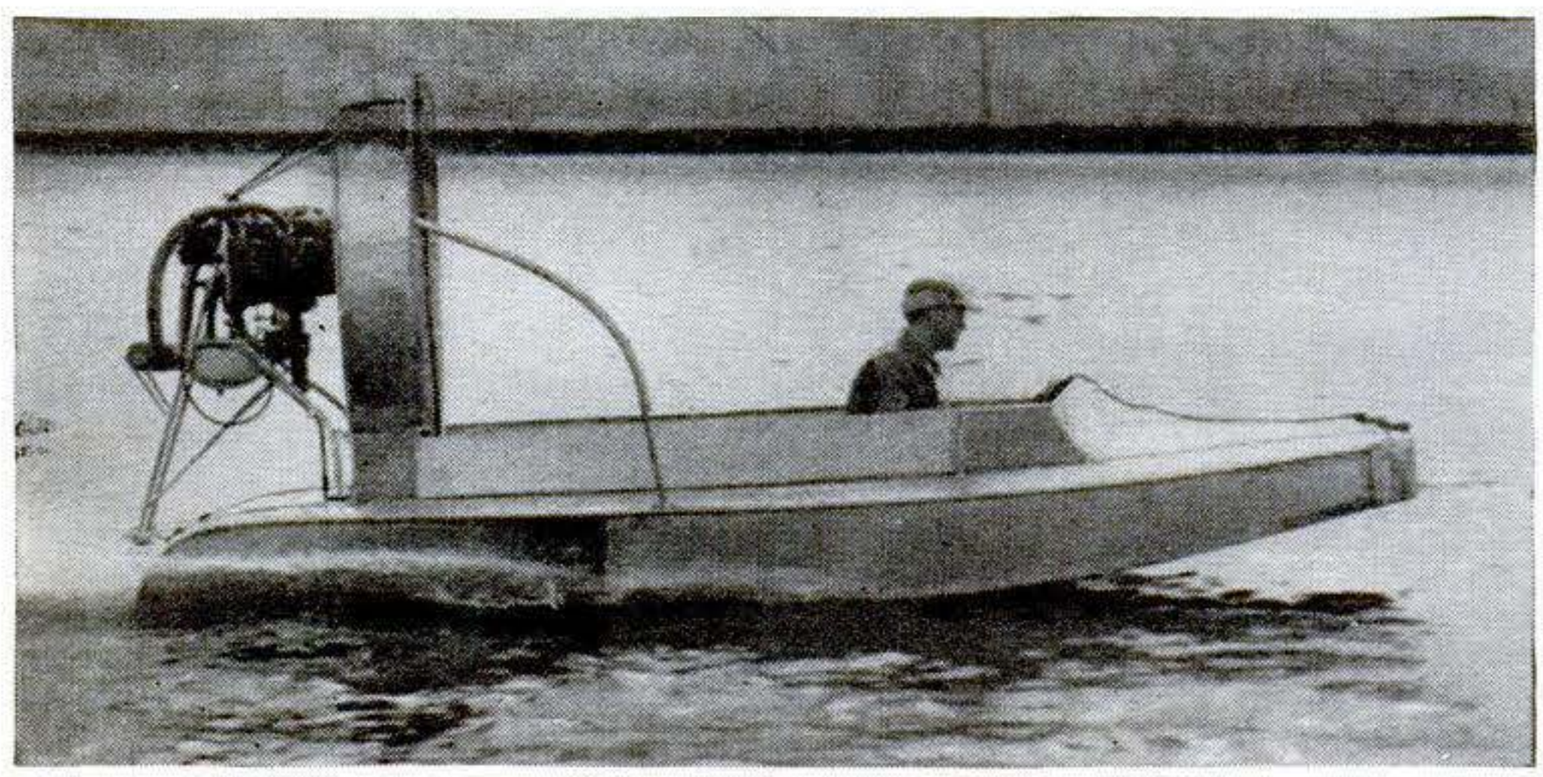
PLANE FOR SMALL-TOWN FIELDS, Saturn 75, is planned for postwar production by Lockheed. This all-metal, high-wing transport will take off in 1,055 feet, and can land at less than 75 m.p.h. Powered with two 525-hp. Wright engines, it can cruise at more than 200 m.p.h., and has a range of above 1,600 miles loaded with eight passengers, a two-man crew, and baggage. It has a tricycle landing gear.





NEW GEARING for aircraft instruments achieves transmission of motion by an actuating cam and helicoid unit developed at the Certified Gauge and Instrument Corp., Long Island City, N. Y. The new mechanism, shown at the left, is less subject to wear, friction, and jamming from particles of dirt than the conventional type at right.



SHALLOW DRAFT, air-propelled boat, designed by Cecil S. Williams and Hortin Jensen, biologists of the Salt Lake City office of the Department of the Interior, can penetrate hitherto inaccessible wildlife habitats. A very light hull and a stern-mounted airplane propeller combine to give a speed of 40 m.p.h. in water an inch deep.

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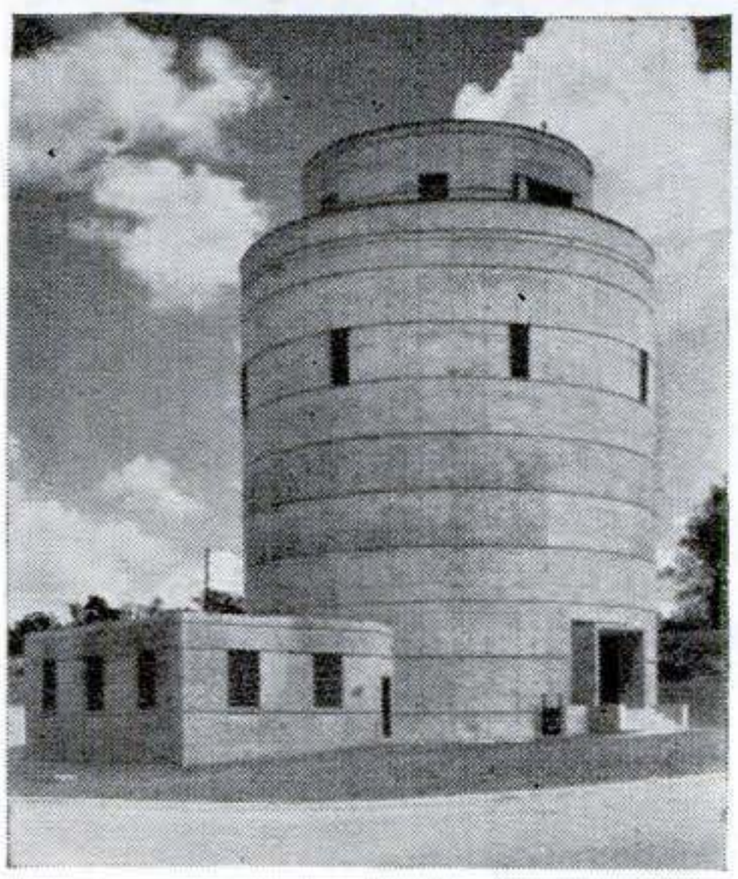
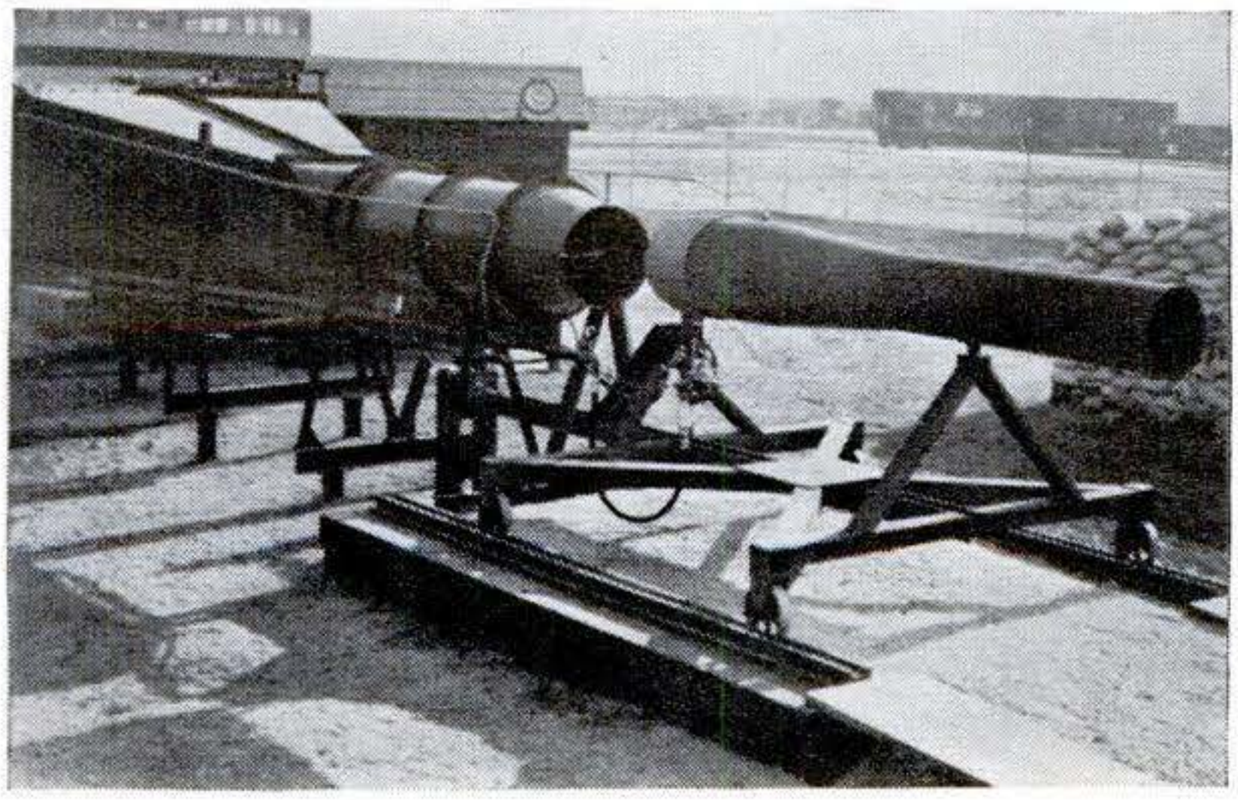
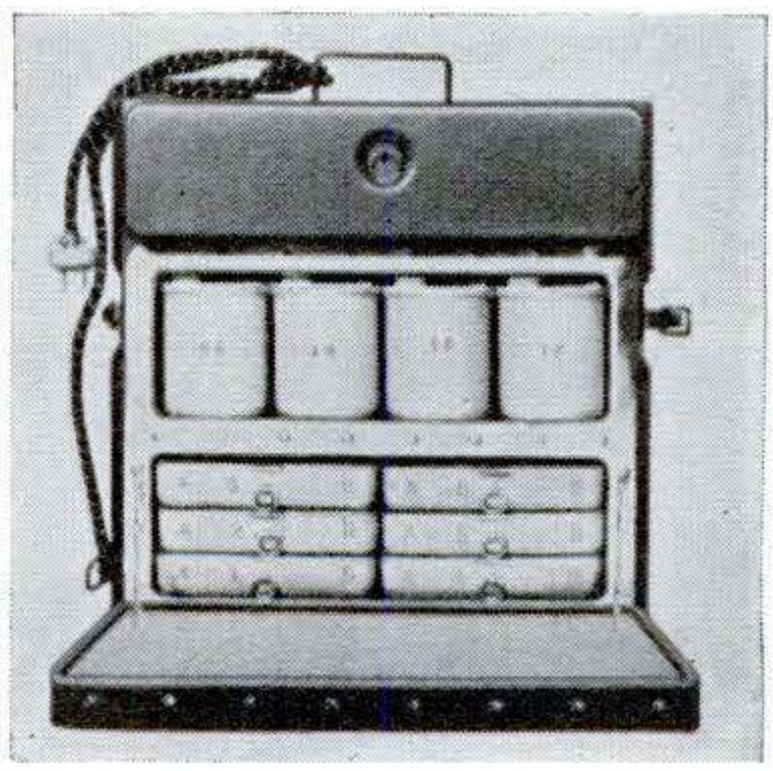


VERTICAL WIND TUNNEL. Certain tests hitherto impossible to perform, involving the study of airplane spin, experiments with helicopter rotor blades, and research into parachute behavior, are now being conducted at the 80-foot concrete vertical wind tunnel recently erected by the Air Technical Service Command at Wright Field, Ohio. View above shows interior, looking upward. Polished maple walls minimize airflow turbulence. A nylon net catches model planes, which are operated by remote control, at the end of each test. At the roof, a 16-foot, four-bladed wooden propeller creates drafts of more than 100 m.p.h.

ROBOT-BOMB ENGINE, reproduced from a mutilated Nazi V-1 that fell in England, is shown being tested in front of a 400-m.p.h. wind tunnel. This gas-fueled engine is one of a large number made by the Ford Motor Co. for Army experiments. It needs a high-speed blast of air to keep it in operation. A gate at the front end of the engine tube opens to admit air for combustion, and closes with each explosion to prevent loss of power. In operation, the engine sounds like a mammoth outboard motor. Over all, the bomb measures 17 feet in span, 27 feet in length.





HOT FOOD FOR FLYERS is served in the air from this electrically heated cabinet containing precooked chow. It was developed by the Very Heavy Bomber Technical Command for B-29 crews. Each drawer contains a meal for one man.

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"JET" vs. "PROP"

500-MILE-AN-HOUR SPEED WILL CHANGE AIR-COMBAT TACTICS

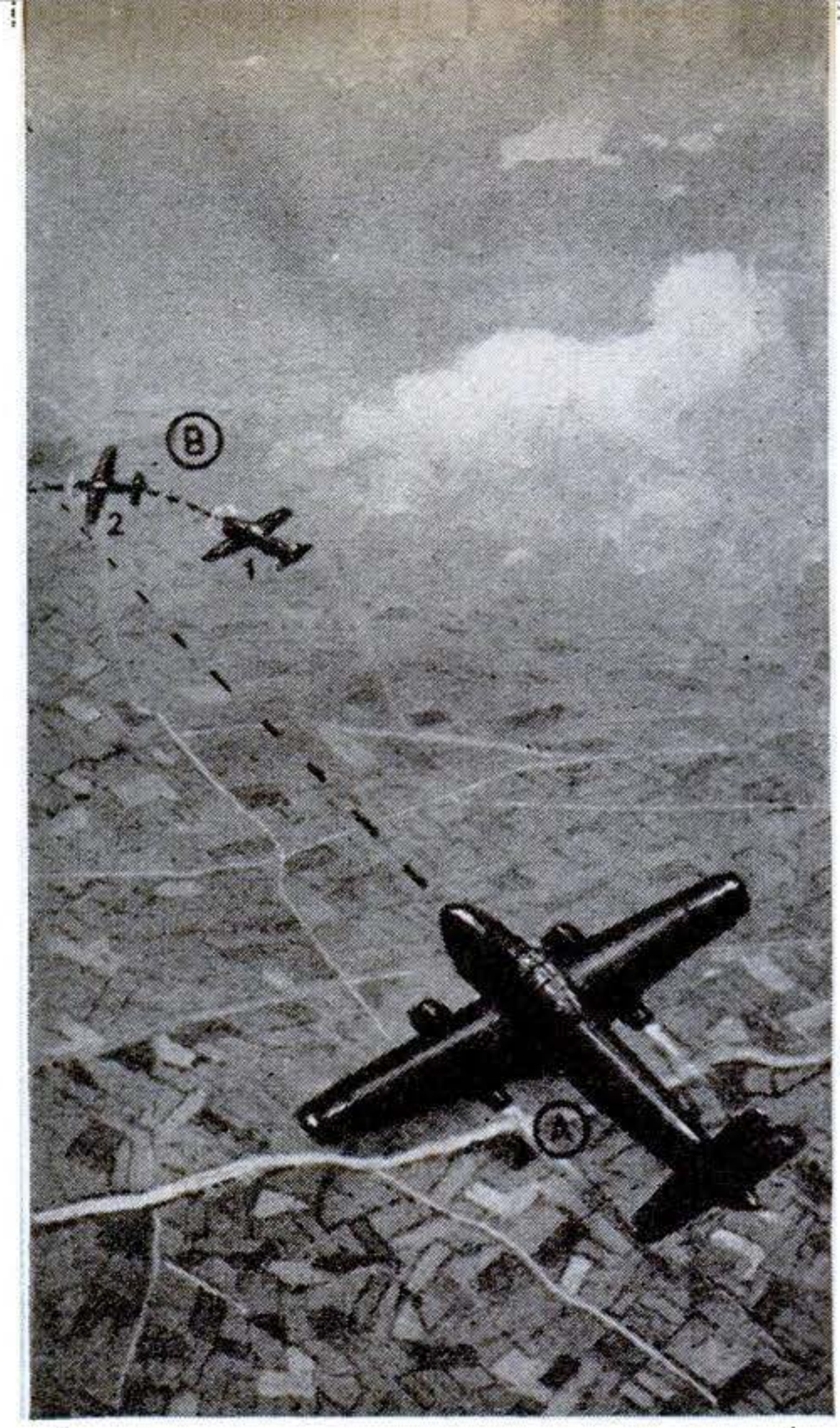
THE entry of the jet-propelled plane into aerial combat on both sides might very well revolutionize sky fighting. The speed of the new craft is now said to be around 500 m.p.h., and already there is talk of 700 m.p.h.

This tremendous increase of speed, coupled with the jet plane's extraordinary rate of climb, would appear to give it a vast advantage over the propeller-driven ship. However, the jet has a definite weakness—lack of maneuverability.

The extreme high speed of the jet plane prevents it from making a turn in anything like the short distance possible to the average fighter. The pilot, if flying at top speed when confronted by a foe, must either go into a long glide or zoom suddenly.

These sketches, drawn for the *Illustrated London News* by G. H. Davis, show how the jet plane attacks the prop plane, and how it, in turn, may be attacked.

What will happen when jet meets jet in the skies is problematical. Possibly the aerial dogfight will revert from a horizontal to a vertical plane.



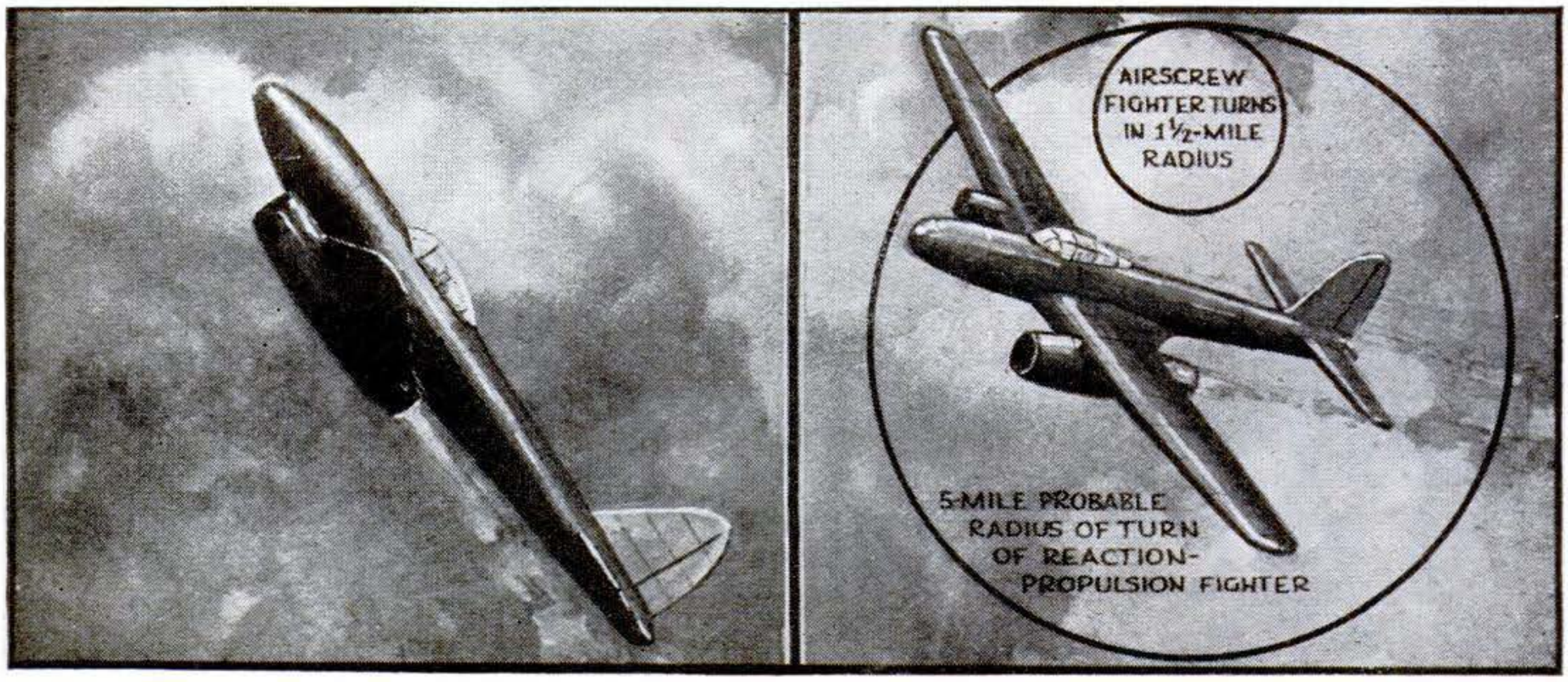
PROP-DRIVEN PLANE'S

1 A jet plane (A), zipping along at a 500-m.p.h. clip, swoops in behind a "prop" fighter (B) and prepares to attack it. But the other pilot spies his foe and makes a sudden sharp turn to the left

JET'S CLIMBING SPEED IS OFFSET BY BIG TURN RADIUS

A big advantage of the jet-propelled airplane, in addition to its terrific speed, is its phenomenal rate of climb. Thus future aerial warfare may reach heights where combat has heretofore been impossible

The disadvantage of the jet plane lies in its lack of maneuverability at extreme high speed. It requires about five miles for a complete turn, as compared with a mile and a half required by an average fighter



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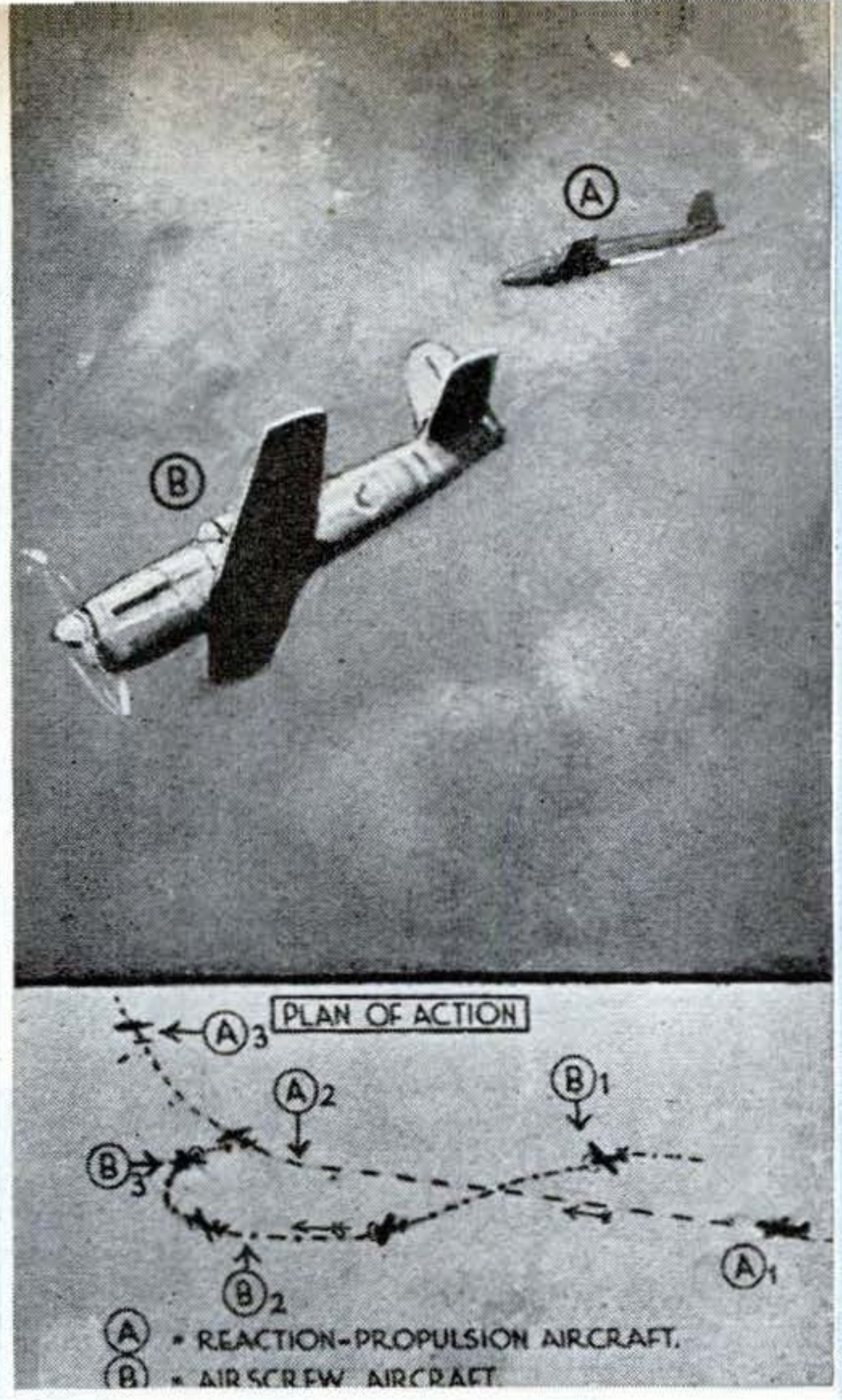
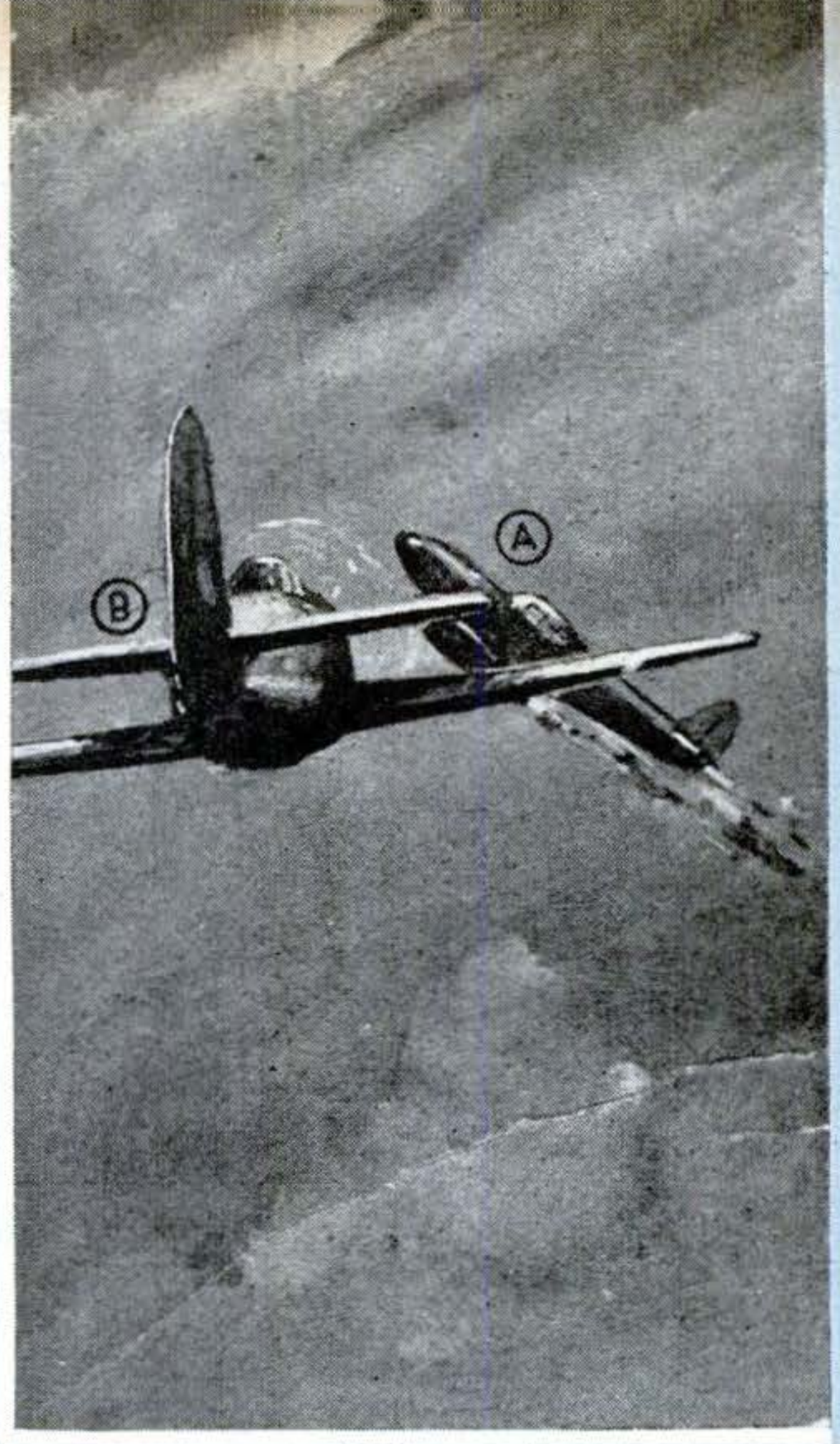




MANEUVERABILITY AGAINST JET PLANE'S HIGH SPEED

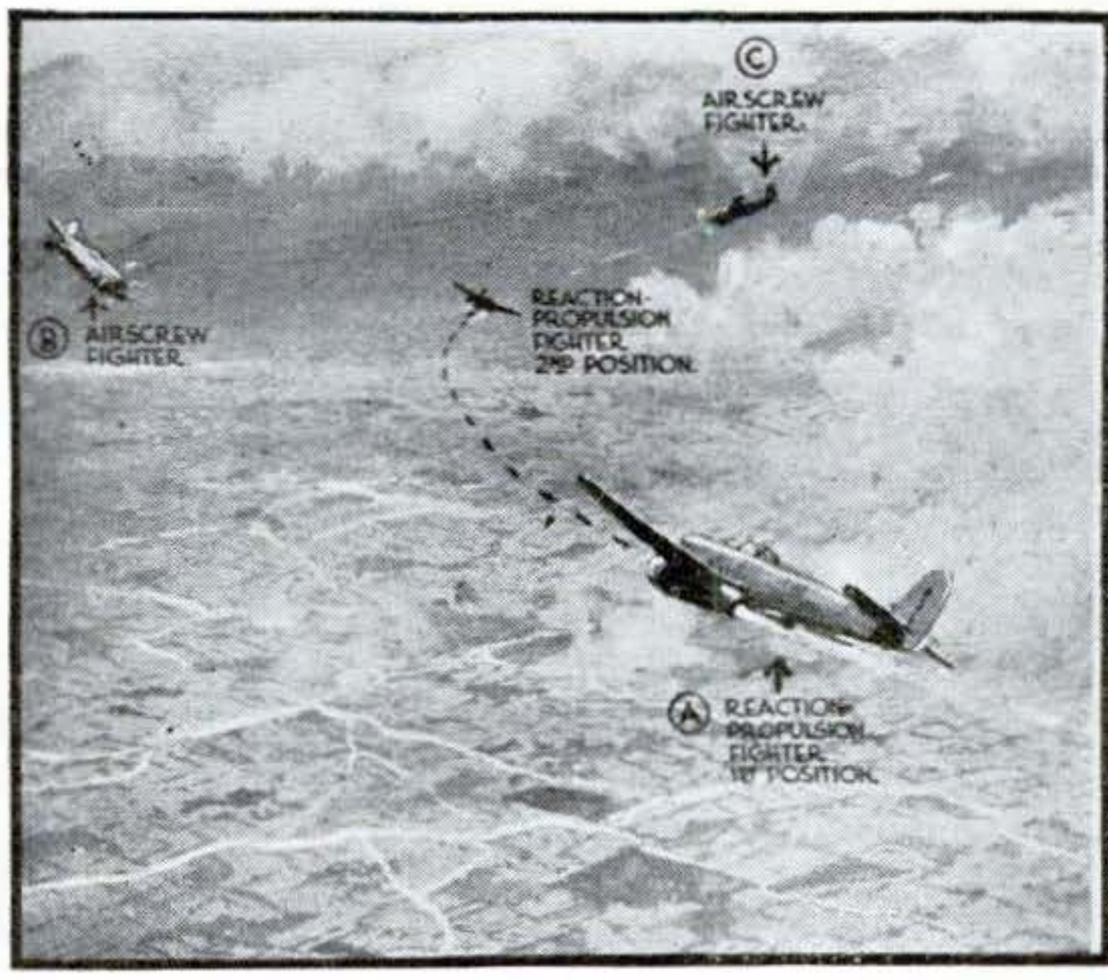
2 Because of the far greater distance he requires to turn in, the jet pilot is unable to keep up pursuit. The other pilot, in the meantime, makes another turn, cutting across the jet's line of flight

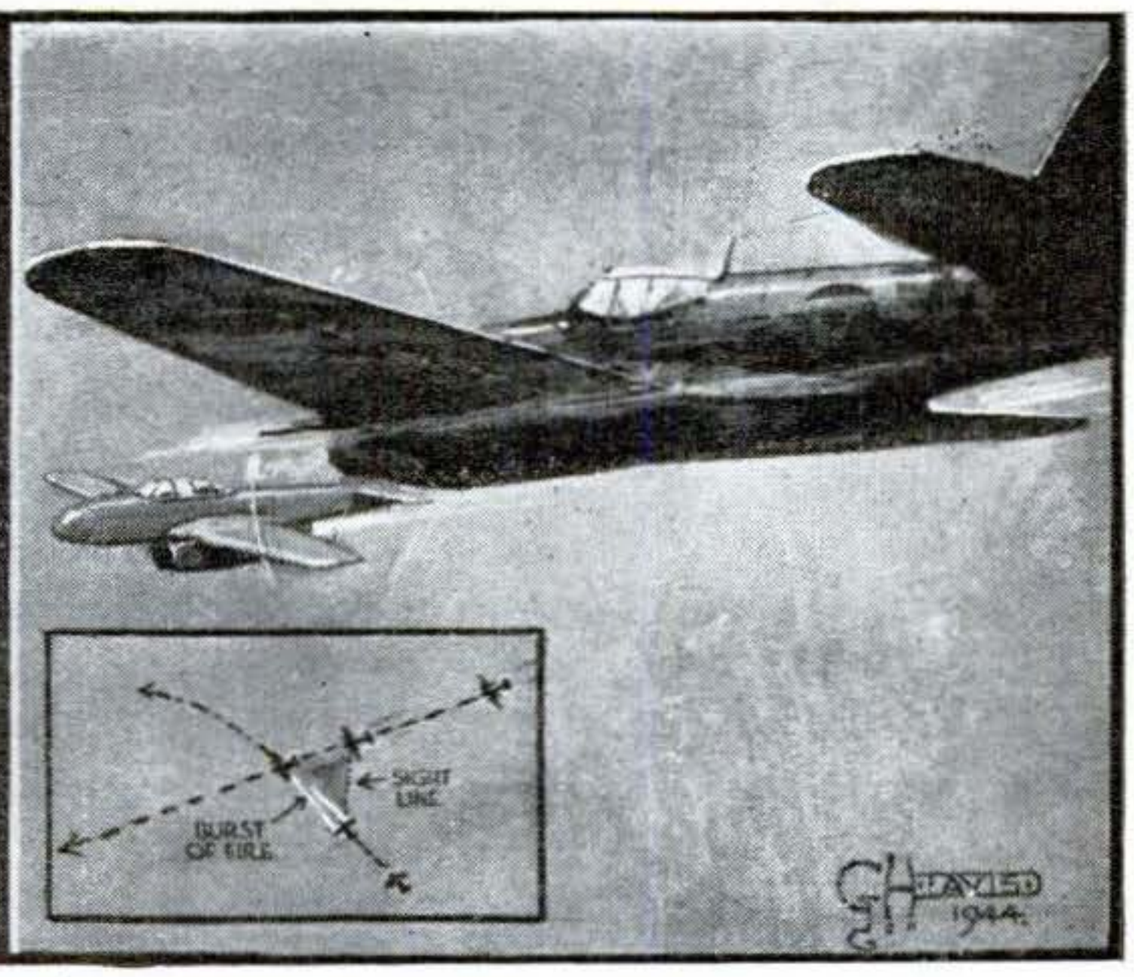
3 Now pilot "B" is in position for a deflection shot, but he has less than a second to shoot, so great is the speed. The jet pilot now must either go into a climb or dive to avoid becoming a target

DEFLECTION FIRING IS MORE DIFFICULT THAN EVER

A possible tactic for prop planes against the jet: A fighter (B) dives down on a jet (A) from the left; the jet begins a long turn to the right, but runs into a second enemy (C), who lets go with a burst

Aerial gunnery will become more than ever a split-second affair as speed goes up. Time for deflection shots will be narrowed to less than a second. Within moments, passing planes will be miles apart





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THE NAZIS FIGURED IT WOULD TAKE 3½ YEARS TO LAND OUR MILITARY RAILROADS IN FRANCE,—BUT—

THEY'RE HIGHBALLING NOW!

We packaged them and put them ashore on the beaches by using "breathing bridges." How this engineering feat was done.

By DEVON FRANCIS

ON JUNE 6, 1944—D-day—more than 20,000 railroad cars and almost 1,500 locomotives sat on sidings and in marshaling yards of southern England. They lay in strings, mile on mile, like delicately articulated centipedes.

The Germans knew they were there. Air reconnaissance had told them so. They knew what they were intended for. And they weren't worried.

The Germans were sure that rolling stock never could be brought across 100 miles of white-capped water and landed in Normandy to carry supplies for the sustained offensive necessary to drive them out of France.

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They held the ports. They would hold them to the bitter end. After that they would blow up the docks. How could the British and the Americans land heavy rolling stock without ports? It was that simple.

Yet on D-day plus 38, long before any Nazi-demolished port and its docks had been reconstructed, those cars and some light Diesel locomotives from those English sidings and yards began moving into France. They went right in across the sloping, sandy beaches in spite of a 24-foot tide.

How this was done, how one of the war's great engineering feats was planned and executed, can now be told for the first time.

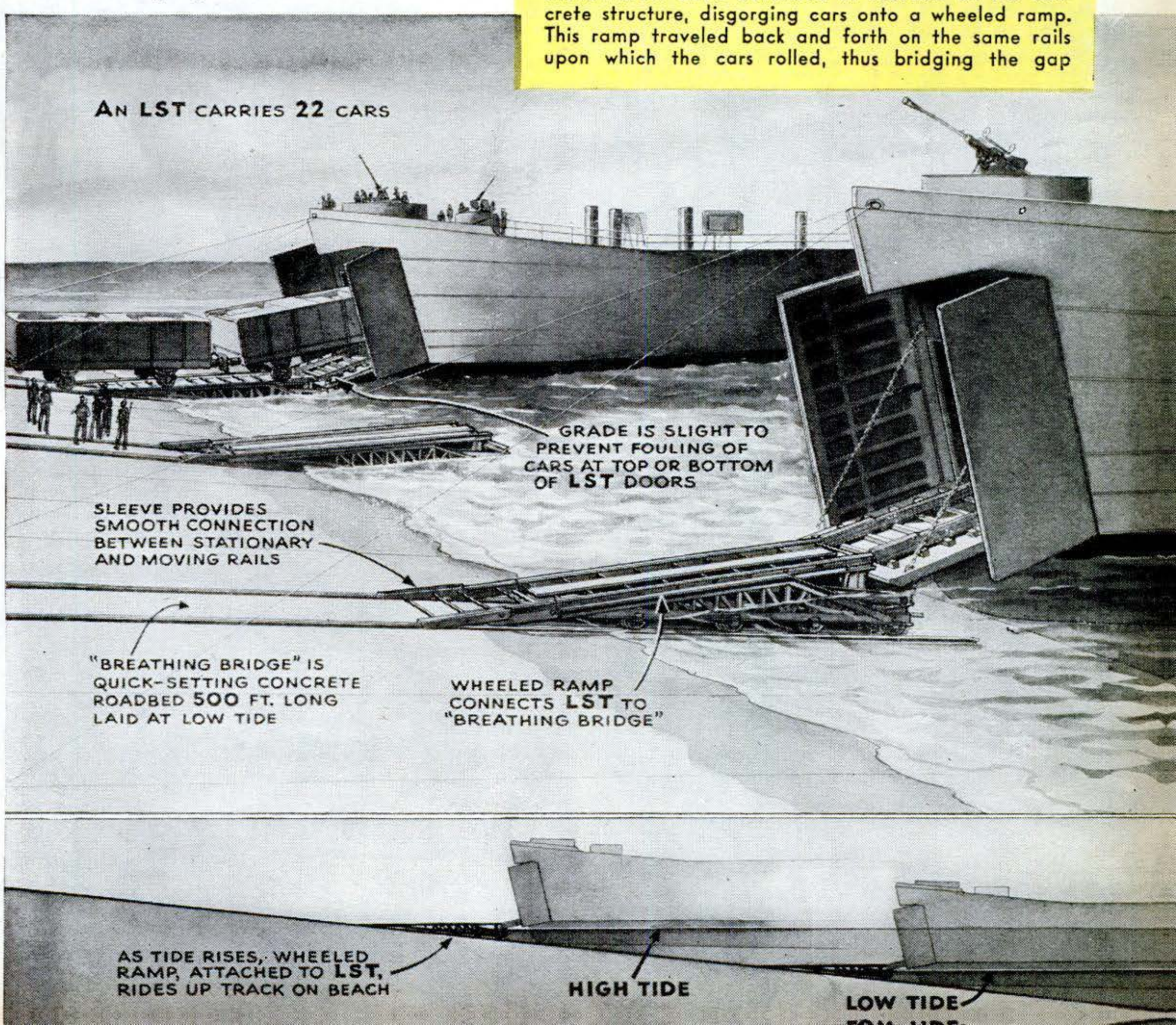
Much had preceded that chapter of the invasion. The Military Railway Service of the Army's Transportation Corps, which did the job, was warring on five continents.

It delivered supplies to China's

Drawings by B. G. SEIELSTAD

HOW RAILROADS WENT ASHORE

A gondola rolls from the gaping maw of a converted LST to a "breathing bridge" on a Normandy beach, and Major Gen. Frank S. Ross, Chief of Transportation in the European Theater of Operations, follows along on a narrow gangplank. Below, artist Seielstad illustrates the principle of the bridge, one of the war's greatest improvisations. As the tide changed, the shallow-draft LST's advanced or receded on the concrete structure, disgorging cars onto a wheeled ramp. This ramp traveled back and forth on the same rails upon which the cars rolled, thus bridging the gap



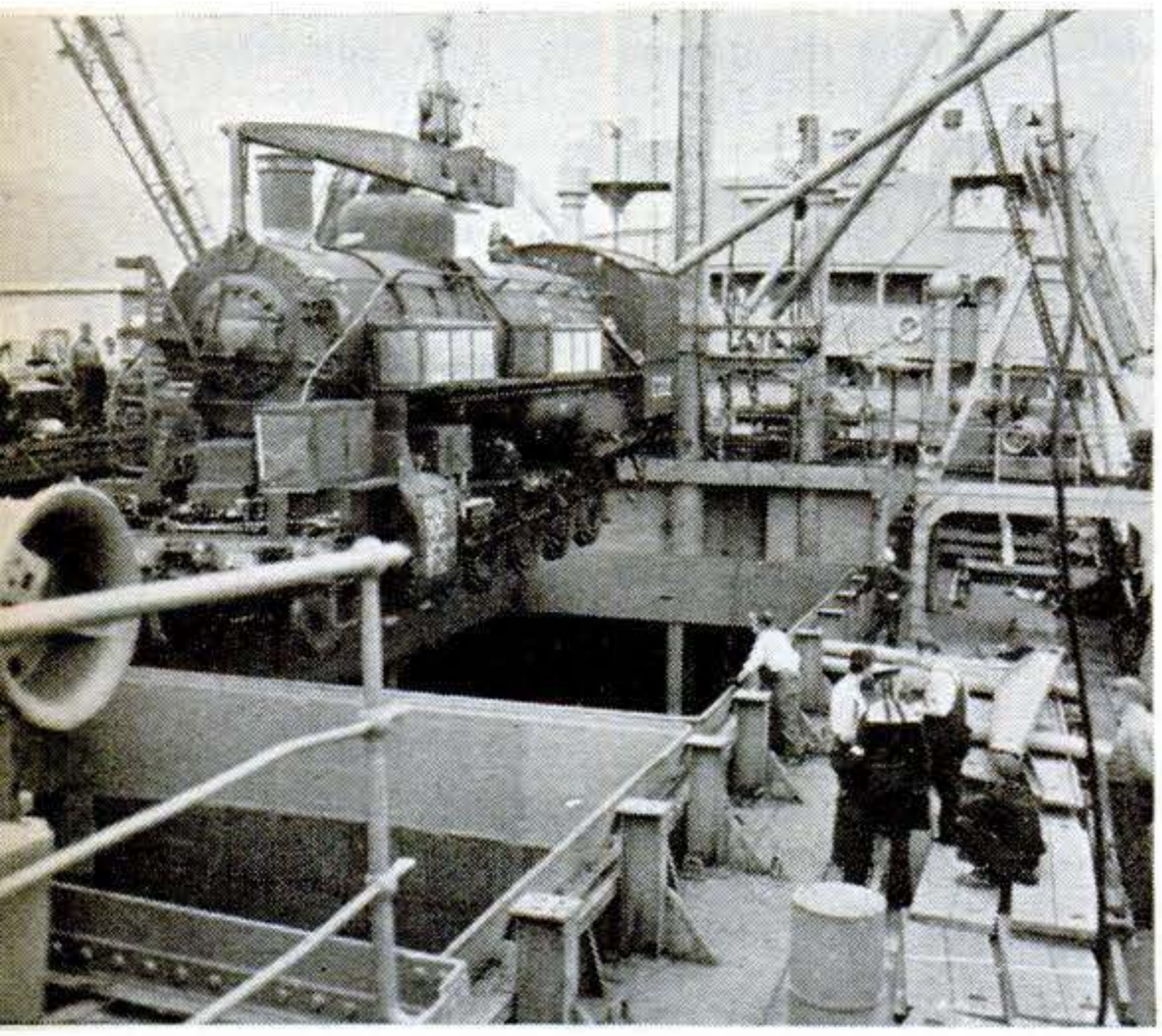
Ledo Road lifeline across rain-swollen rivers. It had taken some of Mussolini's discarded, rusted steam locomotives out of bomb-pitted yards and put them to work in Italy. It had transformed an Iranian railroad known as "the Shah's toy" into a major supply route for rushing arms to the harried Russians.

The United States Army knew, as all armies know, that you can't fight continental wars without railroads. That is why the rolling stock and rail centers of the enemy are A-1 priority targets of both tactical and strategic air forces. That is why 42,000 men and 2,000 officers were recruited from America's great civilian army of railroaders for World War II. That is why American locomotive manufacturers, who turned out only 91 main-line units in 1940, began working around the clock after the Japs struck Pearl Harbor. The United States became the United Nations' railroad arsenal.

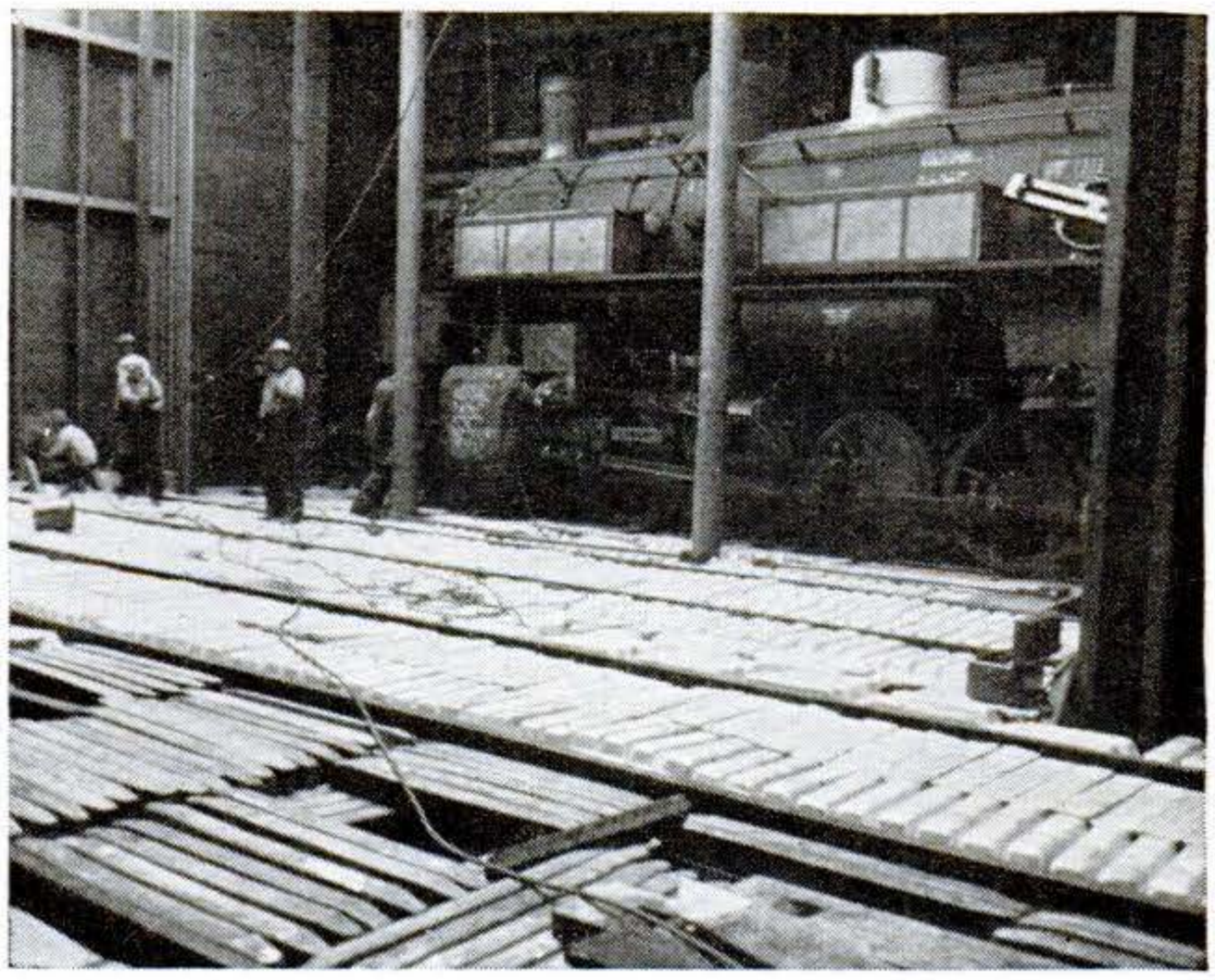
America's war of the rails began in Egypt in 1942. The British needed help. Rommel was knocking on the door to the Suez for an ultimate junction with the Japanese pressing from the east.

Every time an Egyptian locomotive chuffed, its steam and smoke drew fire from a German strafing plane. So the United States supplied Diesel-electrics to the British. It did more. It sent over the 760th Diesel Shop Battalion to keep those locomotives working. The British put their new

HOW LOCOMOTIVES ARE CARRIED ACROSS THE SEA

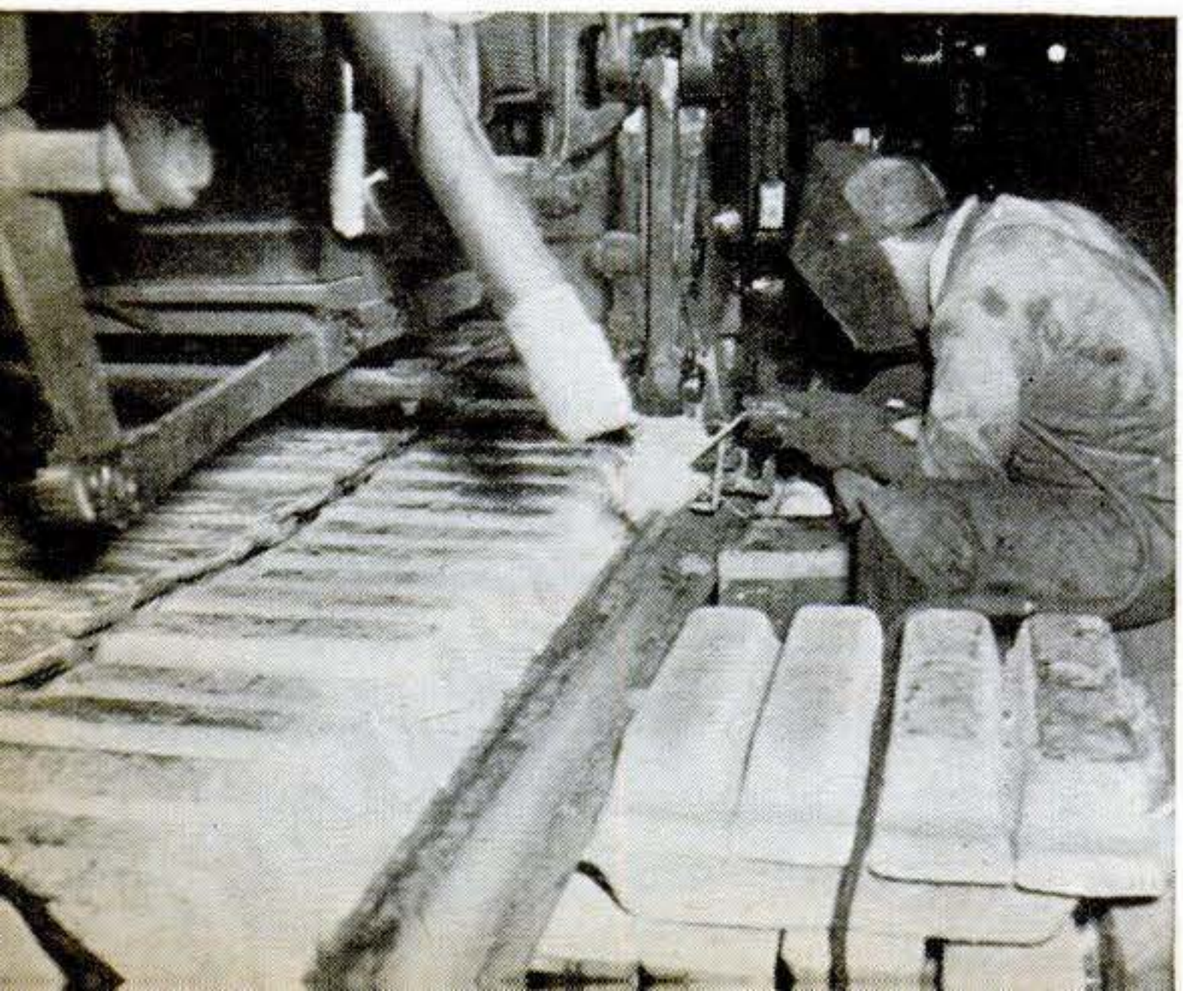


1 With a special grapple fastened to the front and top of a boiler, a locomotive is eased into the hold of a ship by crane. Heretofore, loading crews had to wrap cables around the engines' fat bellies

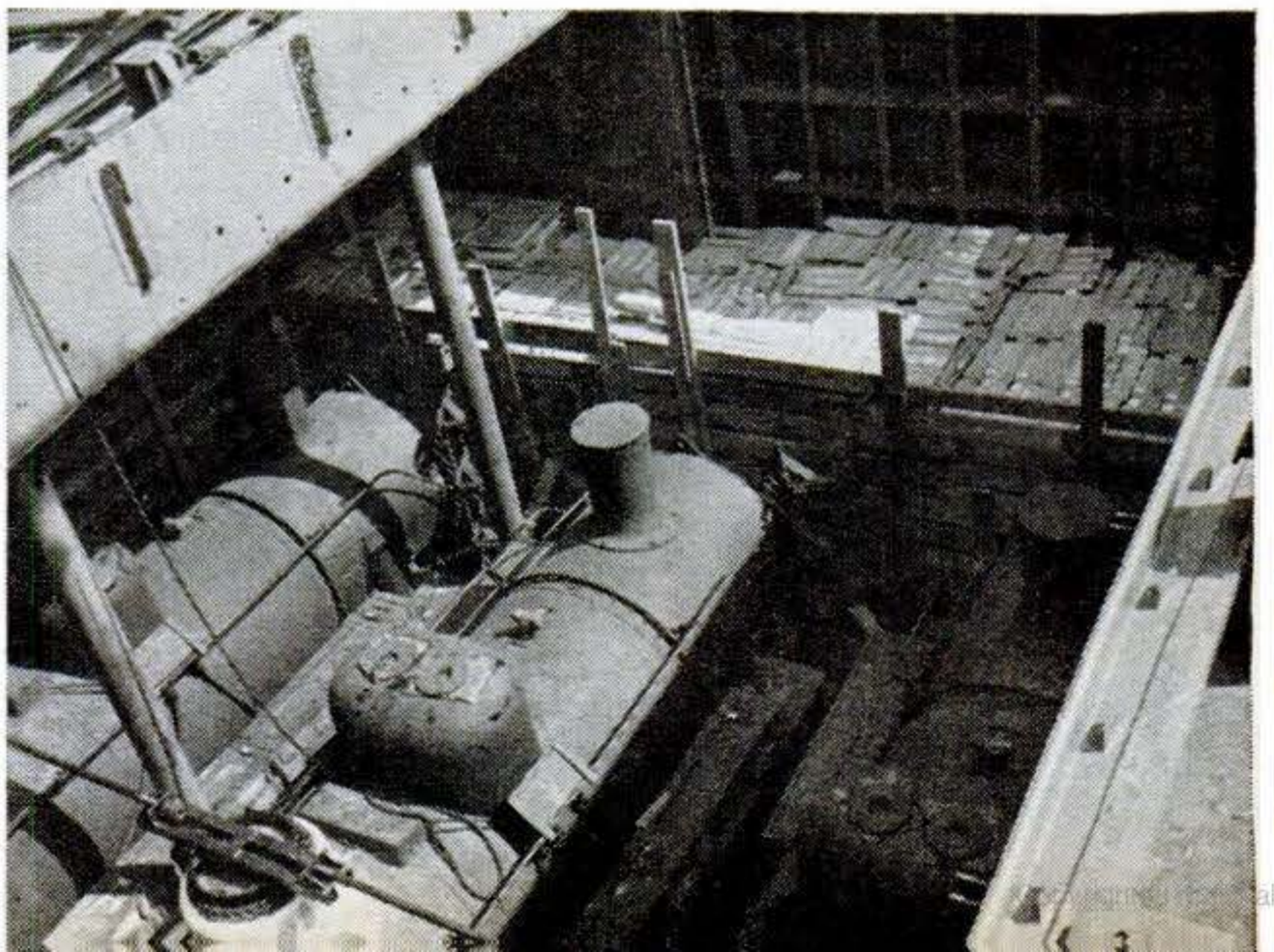


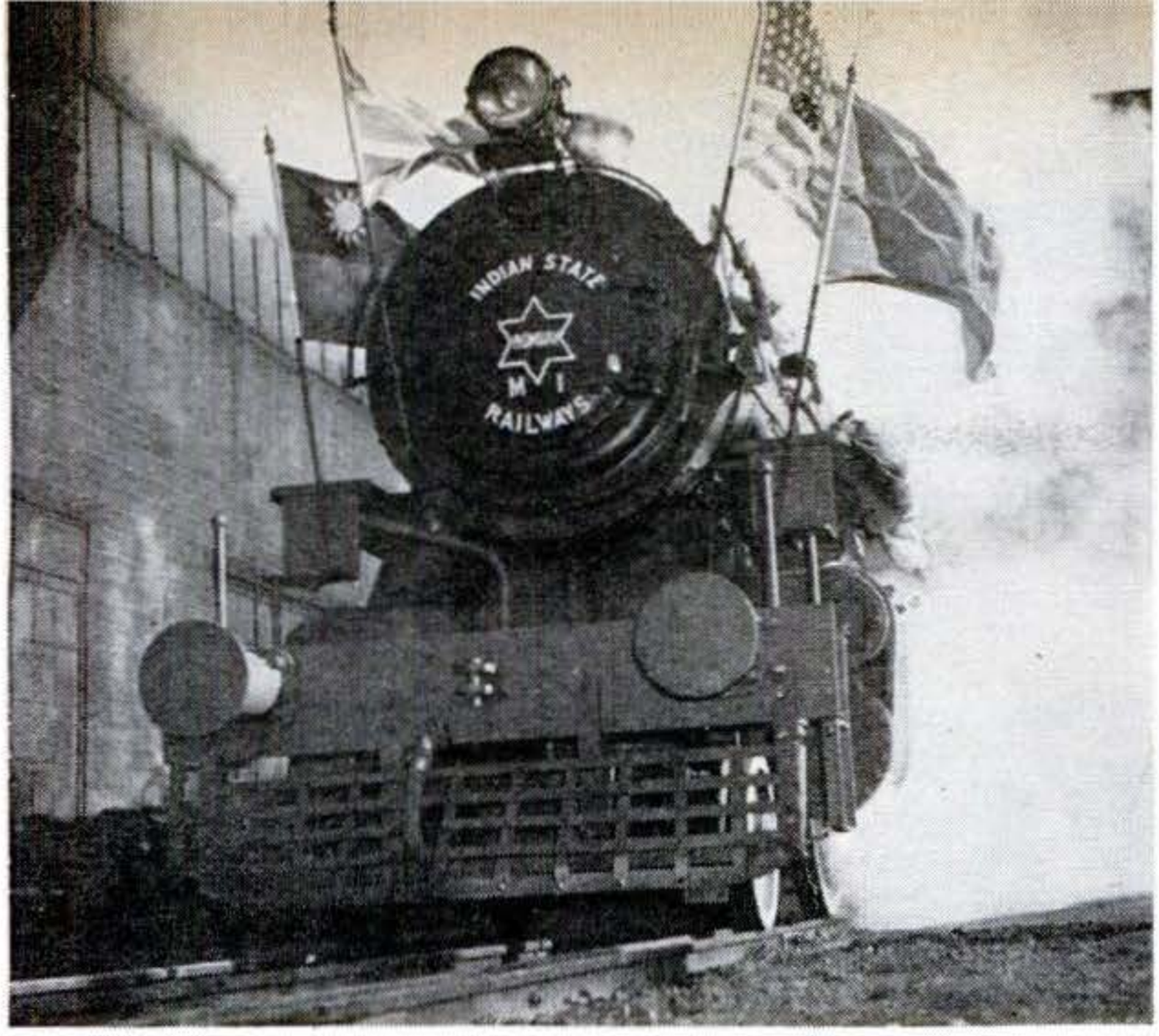
2 All snugged in for the long sea journey. An American-made locomotive—manufactured in quantity for transporting men and supplies to combat areas—is berthed in a hold. Rails in foreground are ready for more

3 In a ship's hold, the locomotive is welded to its rails to make sure the multi-ton cargo won't shift in transit. The lead pigs are insurance against any loosening of the tracks in stormy weather



4 A locomotive gone loco in a storm-tossed ship might easily stove a hole in the hull. So lead pigs are loaded between the bulkheads and wood barricades hard against the engine's snout to keep it rigidly in place





CARS AND ENGINES MUST FIT TRACKS ALL OVER THE WORLD

A difficulty that faced U. S. manufacturers building equipment for United Nations railways was international variation in road gauges. The Canadian-built monster above was made for the Indian State Railway and has a 66-inch gauge. A narrow-gauge line, like the one at right on New Caledonia, has a 36-inch spread. Russian rails are 60 inches apart, while in the "standard-gauge" countries it is 56½

locomotives in the middle of trains where German airmen seldom could distinguish them from the boxcars—or, as Europeans put it, the wagons.

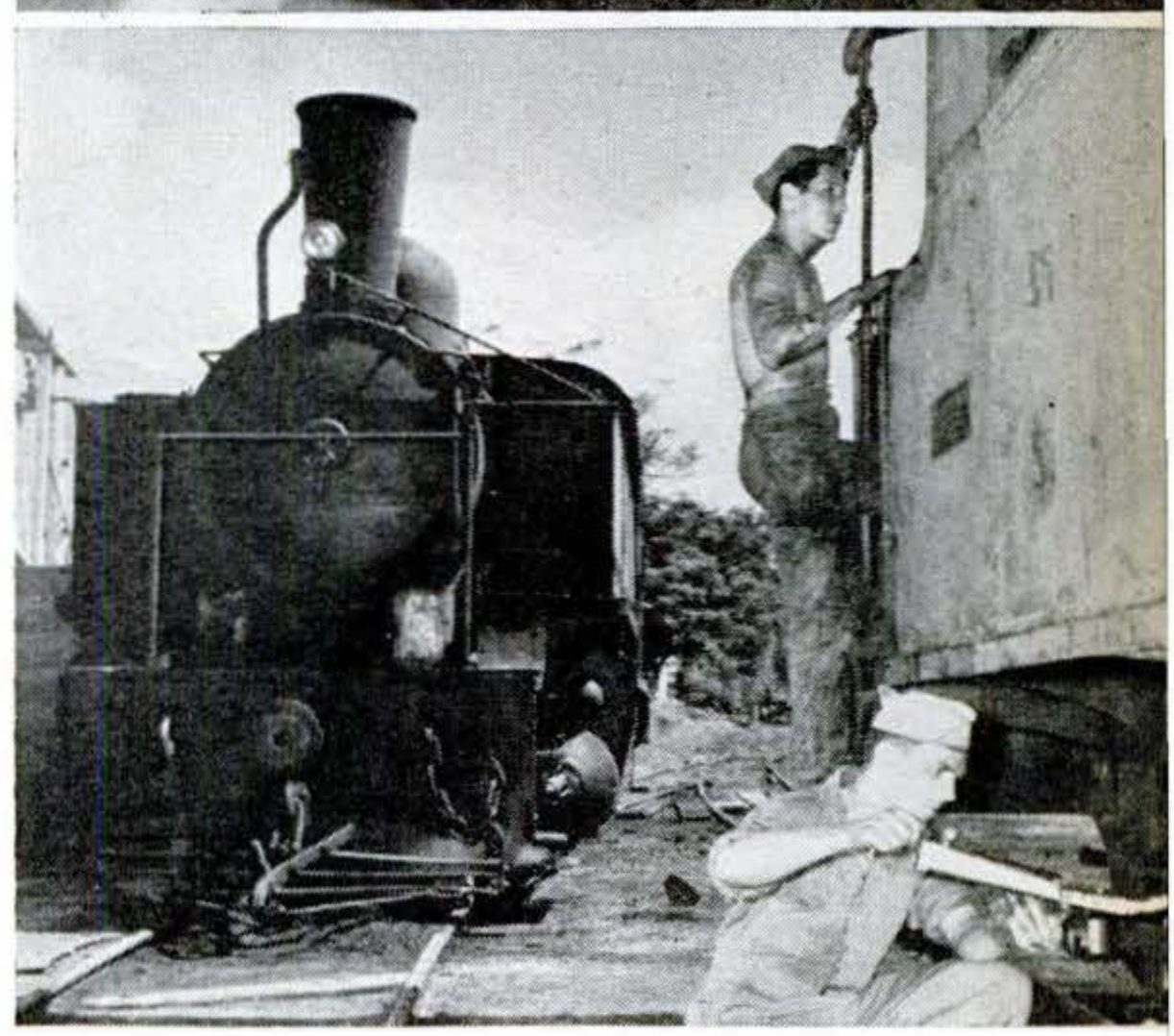
At Naples the MRS plodded into the line of fire to undo damage done by the Germans. German demolition work had been typically thorough. Rails looked like pretzels. Locomotive boilers were sieves. A device designed with diabolical cunning had ripped up untold miles of ties.

The Italians shrugged and said no one could make a railroad out of that debris. The British rubbed their chins and said it would take weeks.

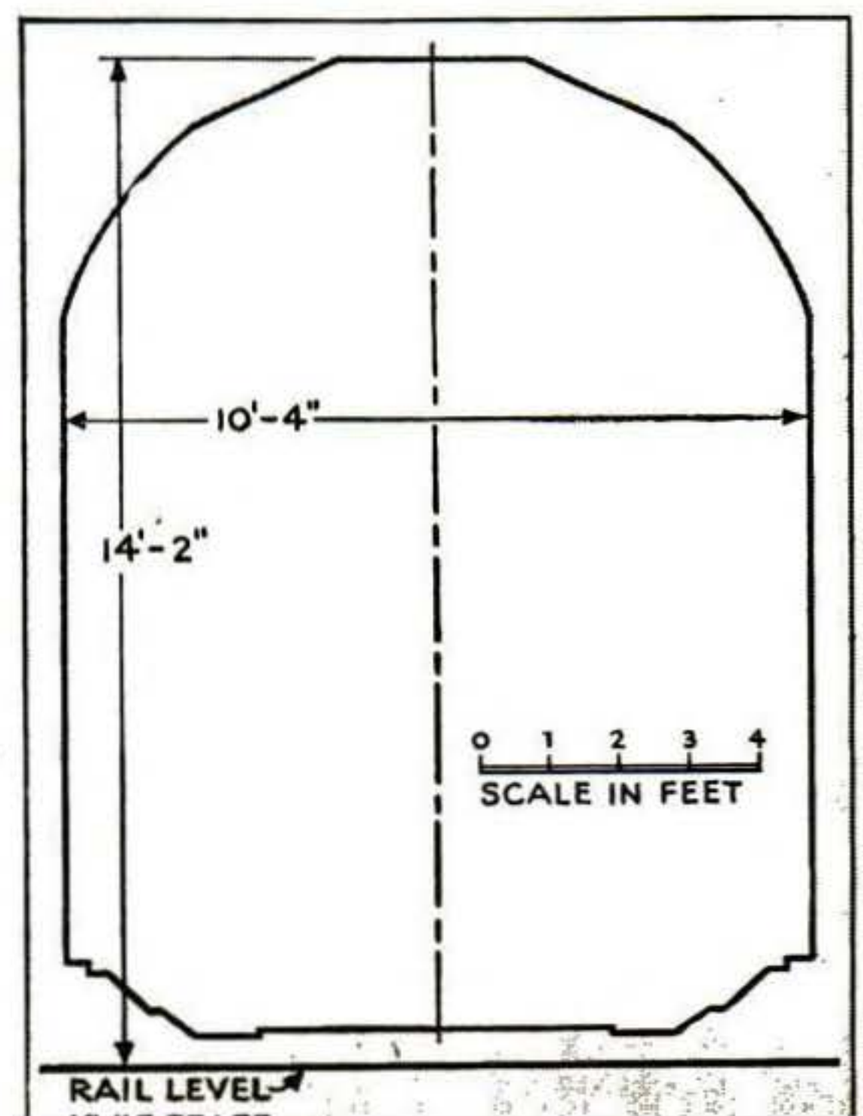
Five days after the American railroaders walked ashore, they had a railroad running!

That job was less complicated than the one they undertook in the mountain-ridden little kingdom of Iran. There had been built "the Shah's toy," a railroad that started nowhere and ended nowhere. Riza Shan Pahlevi, the country's Cossack ruler, had sunk $100,000,000 in it. It snaked up from the Persian Gulf at 65 feet below sea level, in temperatures running to 130 degrees, into the bitter cold of the Elbruz and Luristan mountains. It threaded through 225 tunnels before it reached the capital, Teheran. From Teheran the railroad splayed out to the northwest and northeast. All told, it had 1,500 miles of roadbed, all single-tracked.

The Russians needed that railroad. In



CLEARANCE. To make certain that rolling stock manufactured for European war fronts would clear tunnels, bridge structures, and station platforms, U. S. factories built to the dimensions of the "Bern clearance diagram" (below) covering most of the Continental railways



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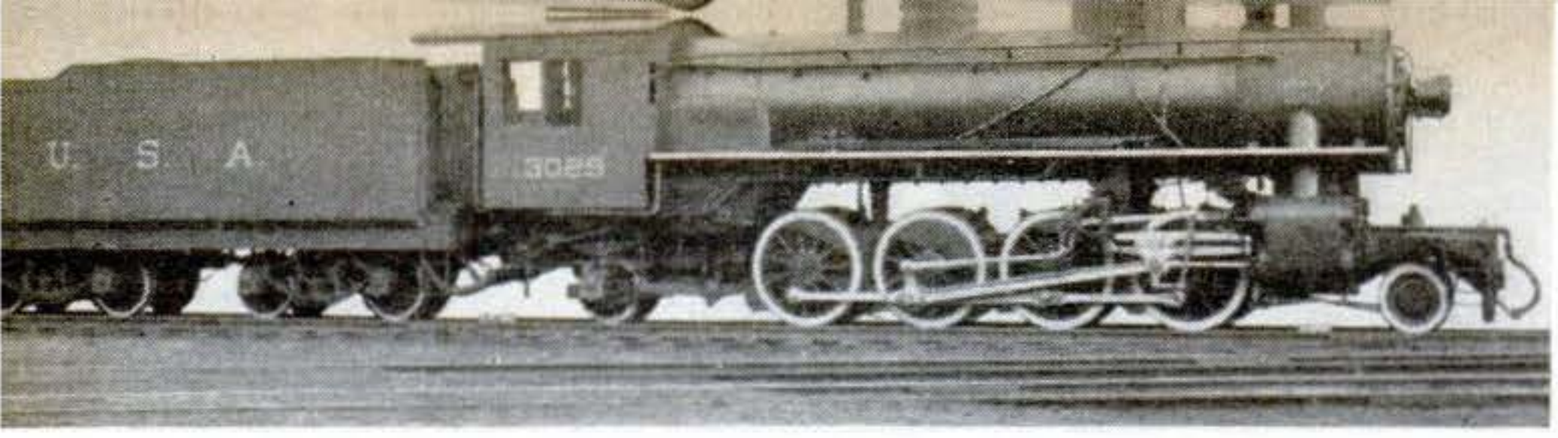
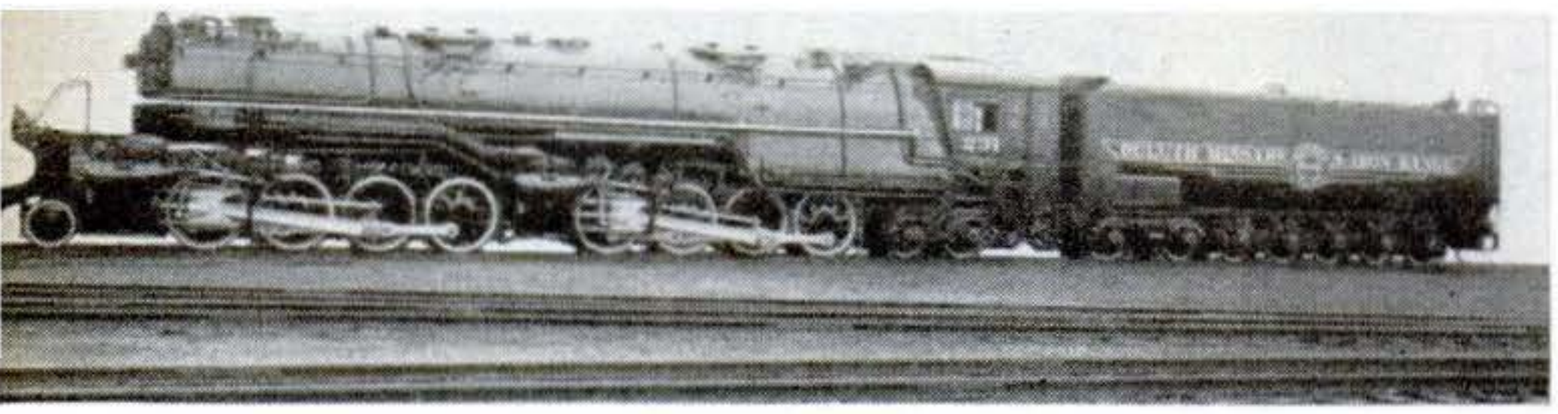
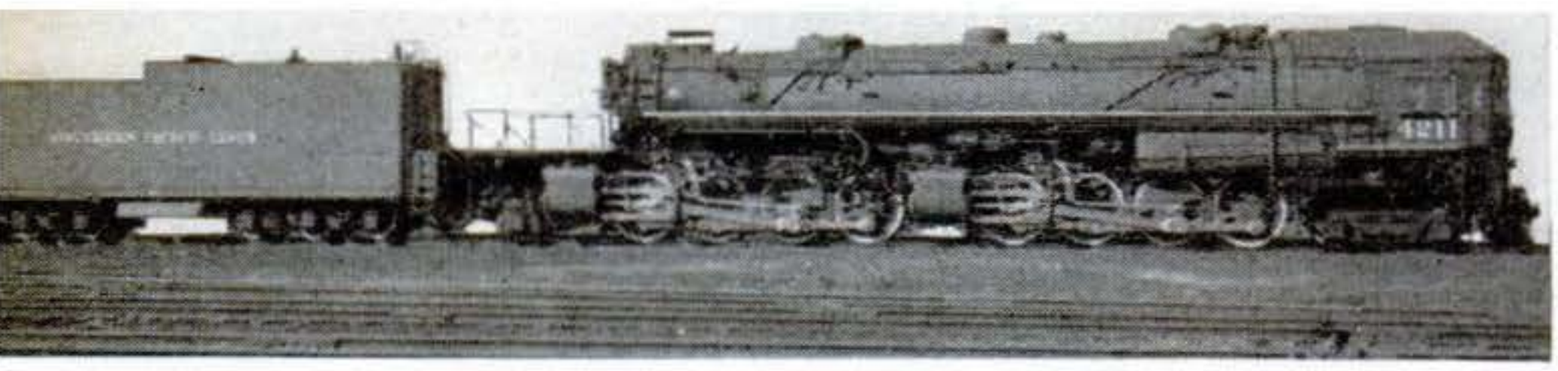


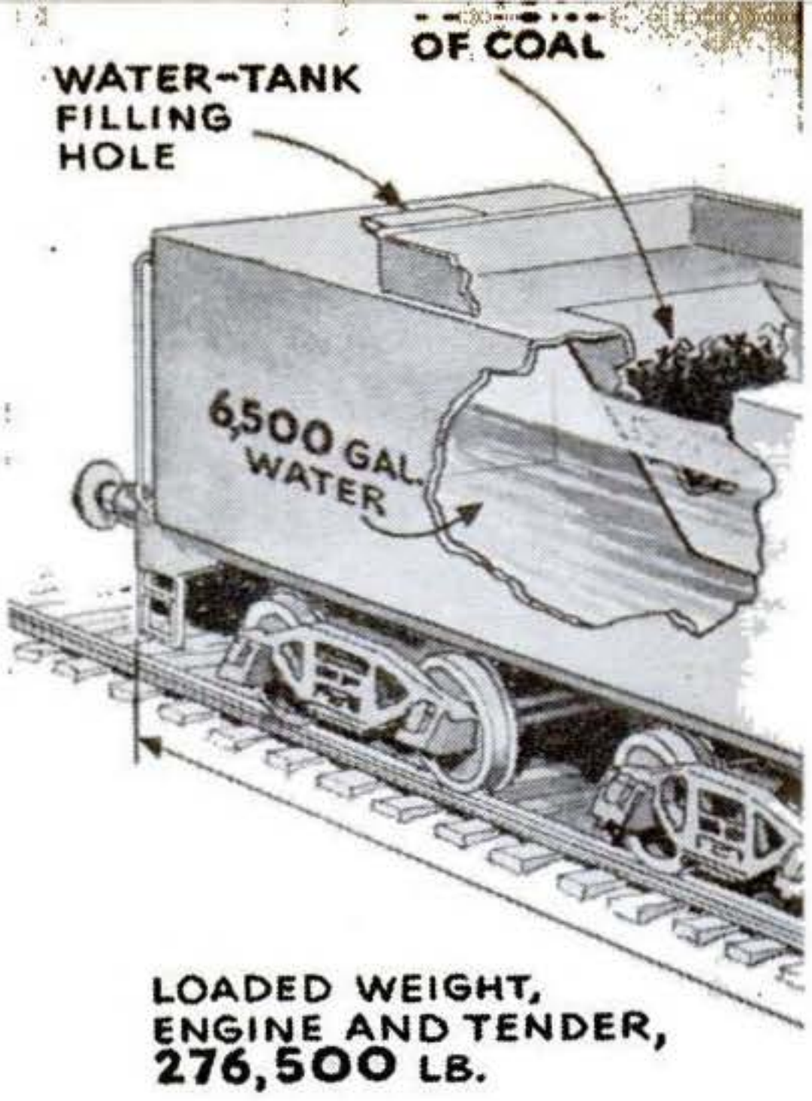
2-8-2. A variation on the 2-8-0, built by the American Locomotive Co. for the War Department, is this engine, which has a rear truck under its cab



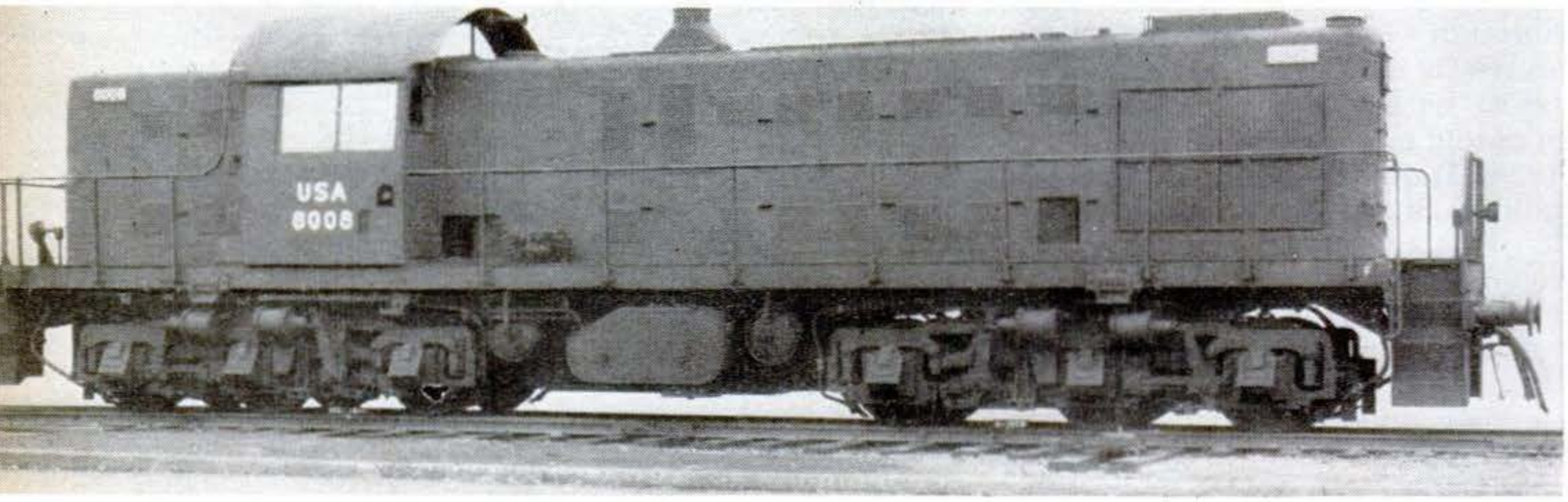
2-8-8-4. One of the world's most powerful freight locomotives is the 2-8-8-4 (16 driving wheels), constructed for the job of hauling great loads of iron ore from the mines of Northern Minnesota to ports on Lake Superior



4-8-8-2. Another 16-driver locomotive, built by Baldwin, is the 4-8-8-2. The "4" in this instance stands for the number of wheels under the cab, as the 657,900-pound giant travels stern first to give clear visibility and freedom from gases in tunnels and snowsheds on the Southern Pacific

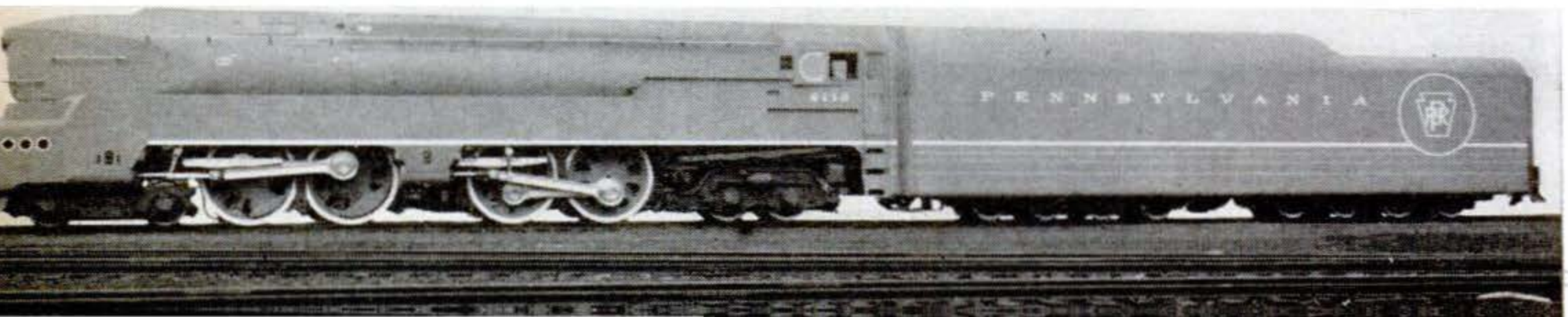


2-8-0. A drawing of the famous locomotive turned out in huge quantities by U. S. makers for war work abroad. Locomotive types are designated by numbers, referring to the count of wheels in the front truck, the driving wheels, and the wheels under the cab (in this case none, hence the "O"). Without its eight-wheeled, 22-foot tender, the 2-8-0 weighs between 60 and 70 tons and is 35 feet long



1,000-HP. DIESEL. This engine was especially designed with 12 driving wheels instead of the usual eight, so as to distribute its 254,000 pounds more evenly on the rails of distant Iran. The roadbeds on "the Shah's toy," as the 1,500-mile-long line is called, weren't built to take a heavier load per wheel

4-4-4-4. Each of the eight drivers of this ultramodern Pennsylvania steam locomotive, driven by tandem-set cylinders, bears a load of more than 32 tons, accounting for its tractive force, or pulling capacity, of 65,000 pounds. The locomotive complete weighs almost 250 tons without its mammoth tender



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TOTAL WATER AND STEAM-HEATING SURFACE, INCLUDING SUPERHEATER, 2,236 SQ. FT.

OVER-ALL WIDTH 9'-3/4"

SAFETY VALVES

SAND BOX

AIR PUMP

HEIGHT 12'-10½"

OVER-ALL LENGTH 61'-2"

57"-DIA. DRIVE WHEELS

WHEELBASE 23'-3"

33"-DIA. PILOT WHEELS

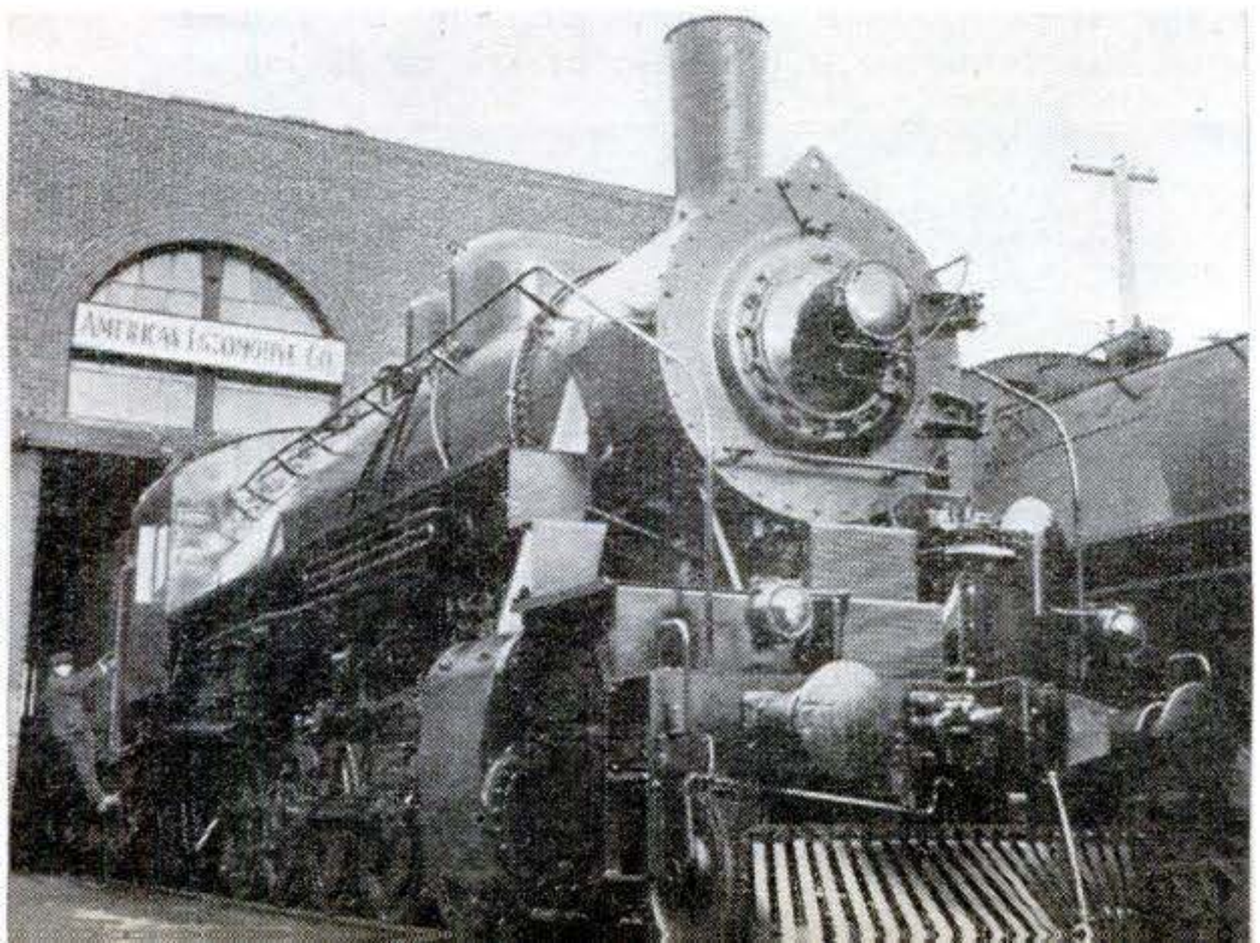
4'-8½" GAUGE

the very critical days of early 1943, the MRS moved in. It found that the British and American locomotives in use were not powerful enough to negotiate a roadbed with hairpin turns at a speed necessary to meet the Russian target of supply at the Caspian Sea. It found that the Persian Gulf port would not accommodate the deep-draft ships streaming over from America.

A fleet of Diesel-electrics—"streetcars," in railroad slang—was ordered. A hundred miles of new line was built from a whistle stop called Awaz to a better port at Khorramshahr. By May "the Shah's toy" was delivering 18 percent more tonnage than the Russians had specified, notwithstanding the fact that natives complicated operations by stealing the oiled stuffing out of journal boxes to make camp fires.

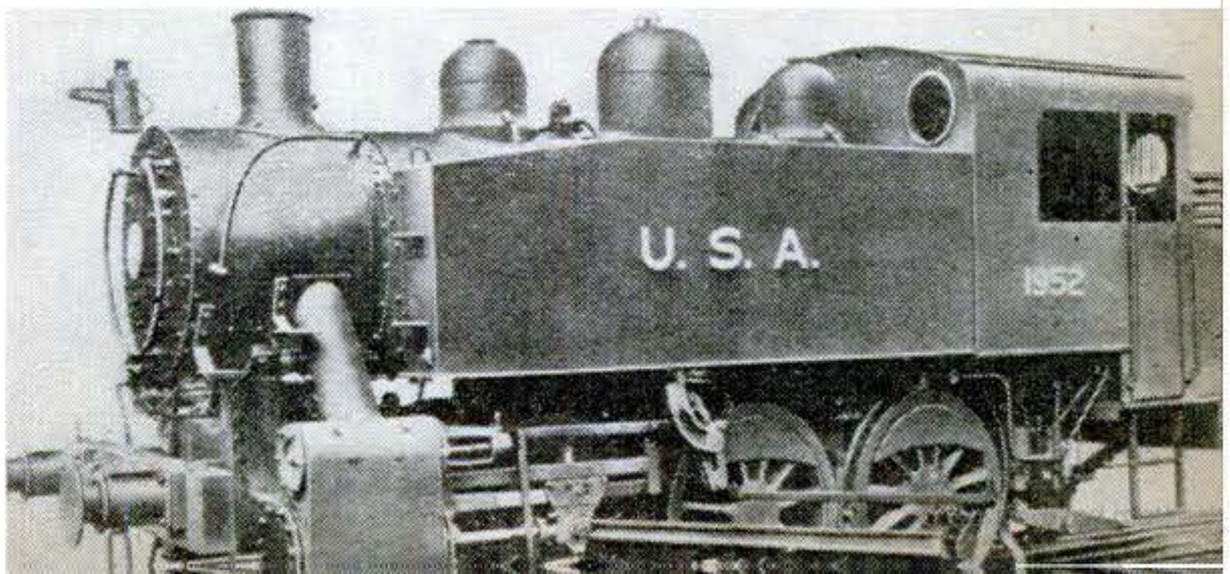
The Normandy operation was something else. Never in a major war had rolling stock been landed on a shore where the enemy stood at the battlements.

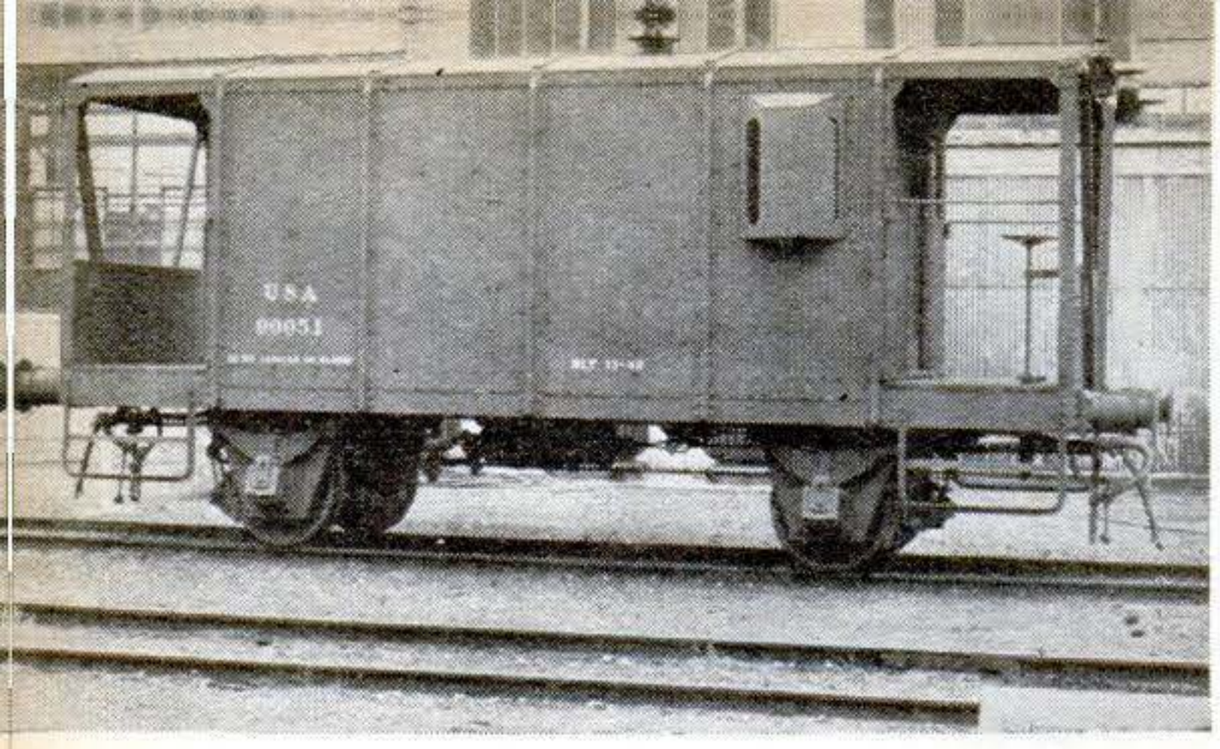
That is where a man named Sidney H. Bingham comes in. In peacetime Bingham ran the New York subways. Emphatic, imaginative, he was put into a uniform with Transportation Corps insignia on his lapels



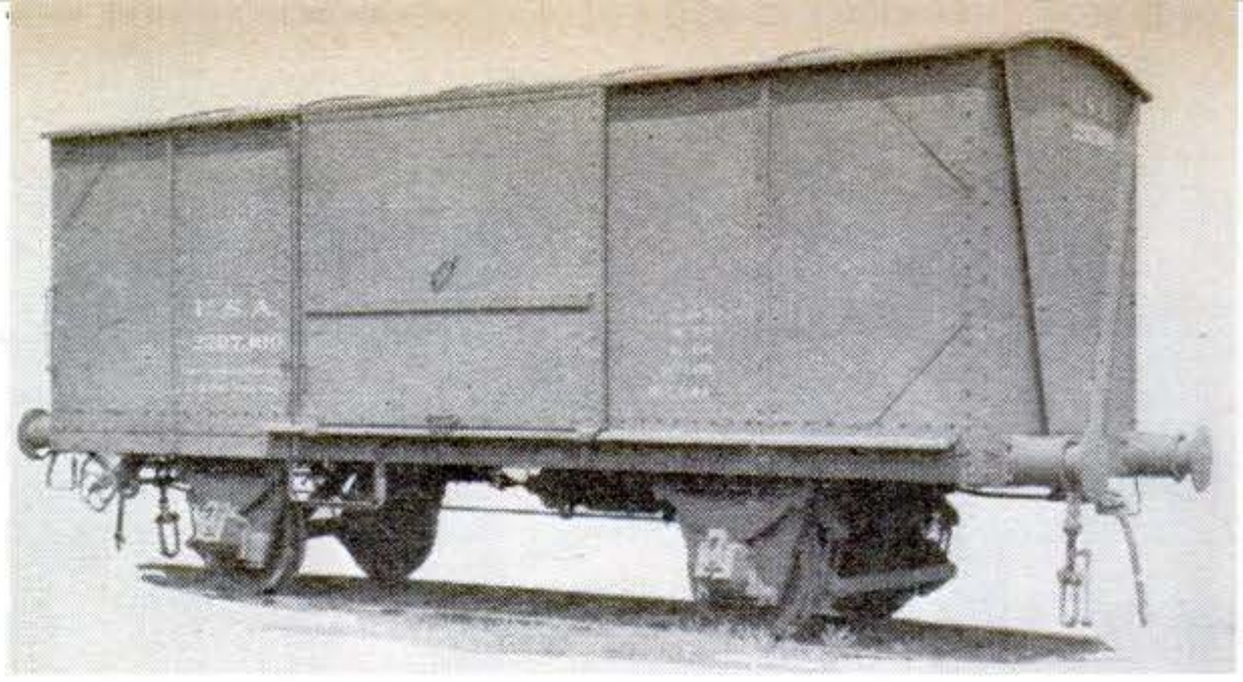
2-10-0. A huge locomotive of a type built for Russia rolls out of the shop to be knocked down and shipped. It has a 60-inch gauge

SWITCH ENGINE. The stubby tugboat on rails is used chiefly at ports by Military Railway Service





CABOOSE. Somewhat different from the domestic type, this end car is built on Continental lines. The slits that look like ports are observation holes for the benefit of the crewmen, who like to see the scenery



BOXCAR. This is the standard 20-ton boxcar constructed by American Car and Foundry for foreign service. It runs around 24 feet in length, stands about 11 feet in height, and has a door on either side

and assigned to planning railway operations for the invasion.

The Military Railway Service had collected the rolling stock for the job. By ordinary means it would take 3½ years to get those locomotives and cars to France, even without German interference. That was as fast as they could be shuttled over in the train-carrying ships the British used in trans-Channel work before the war. Moreover, the British ships would need docks for unloading.

Sitting on a joint British-American board, Bingham, a colonel, made a suggestion: Why not load this stuff into U. S. Navy LST's (landing ships, tank) and roll it across the beaches? The LST's had little or no draft, and he would figure out some way to get the cars and a few Diesel locomotives off the boats.

Somebody in the room snorted. That 24-foot tide would allow just 90 minutes out of each 24 hours for unloading on a beach, granting the stuff *could* be unloaded on a beach.

This was in July, 1942. Colonel Bingham ignored the snort and set to work. Experimentally he laid tracks in an LST. Then he loaded rolling stock in it and sailed into rough water to see whether the boat would behave properly. It would.

Now for the big problem. He laid a "breathing bridge" in quick-setting concrete on an English beach at low tide, fitted a wheeled ramp to the lip of the LST's cargo deck, and rolled his cars ashore regardless of the tide level.

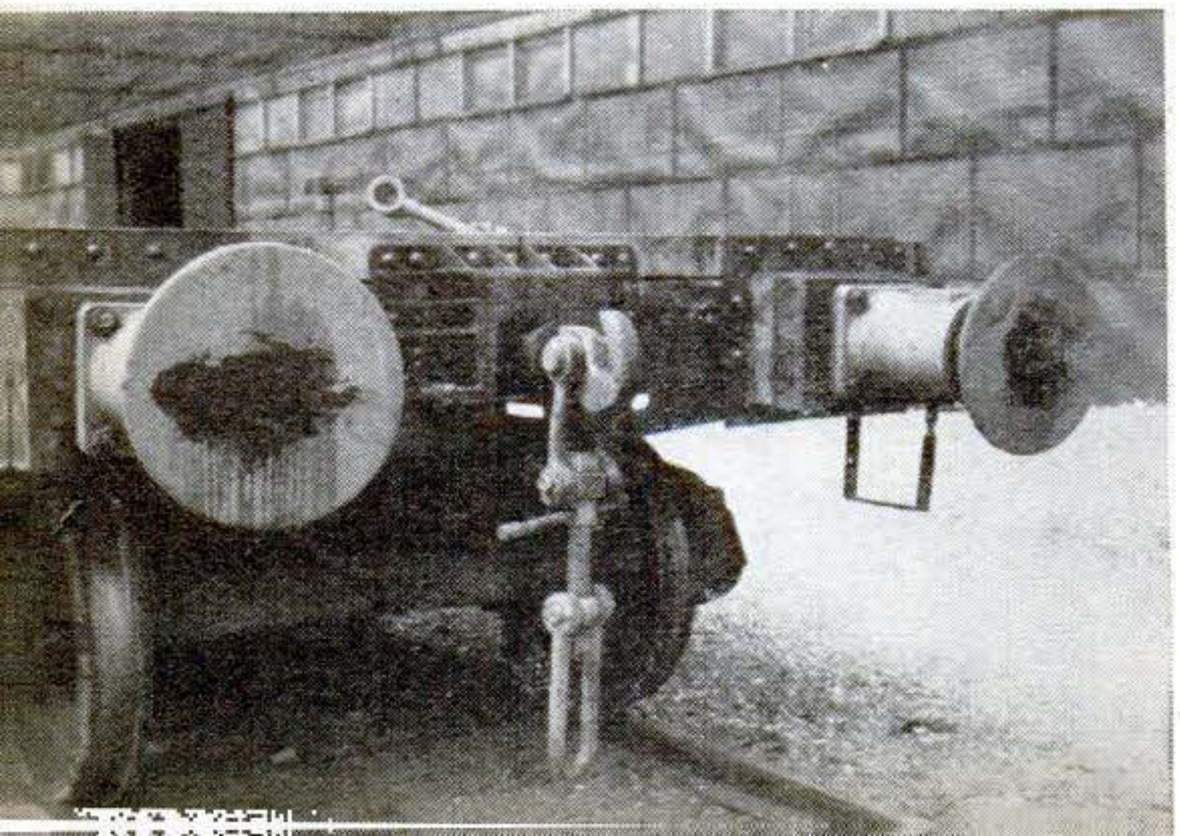
Nobody snorted.

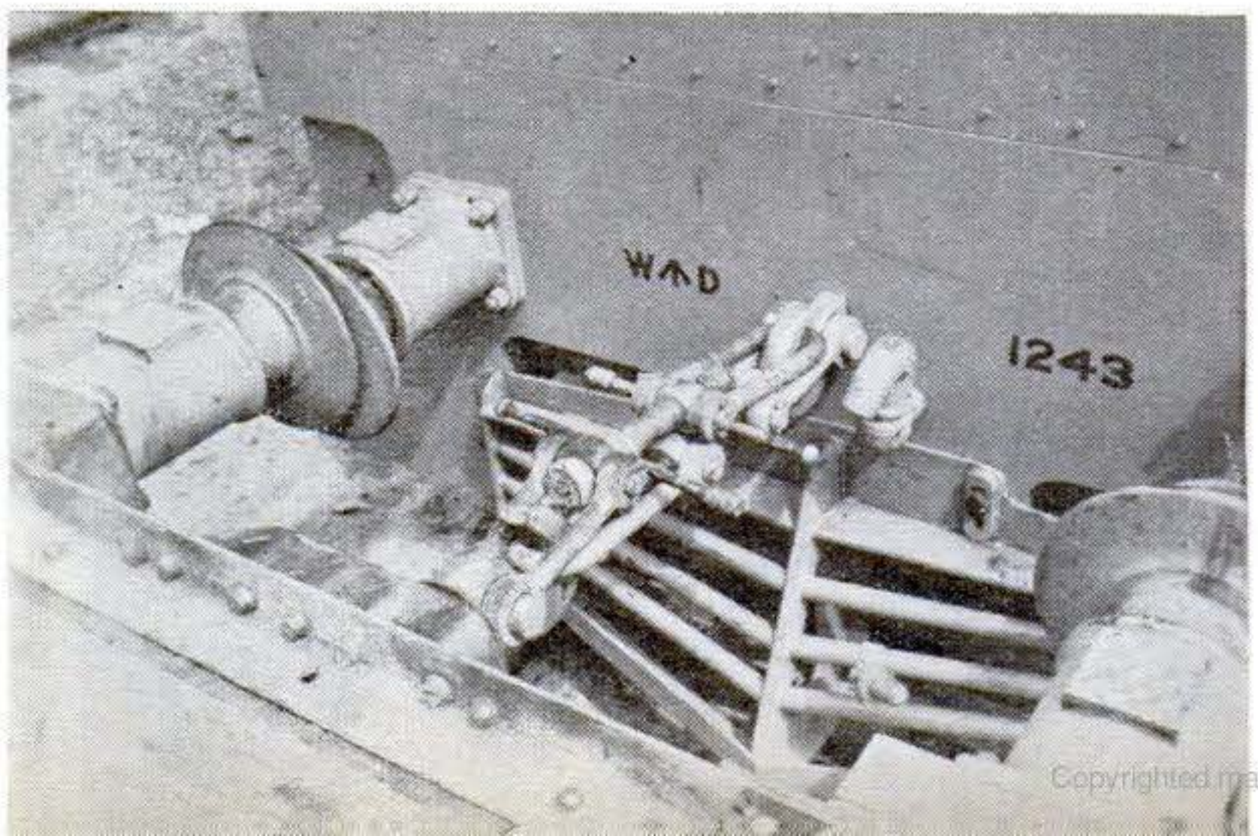
On D-day plus 25 Col. Bingham put down four "breathing bridges" on a Normandy beach at low tide. Thirteen days later he started pushing converted LST's across the 100 miles of open water to the Cherbourg peninsula. Each boat carried 22 cars. It took him exactly 26 minutes to load in England and exactly 21 minutes to unload in France. He knew. He timed it.

By mid-October, aided by some of the Cherbourg docks slowly coming back into use after the usual Nazi destruction, he had delivered a total of 20,000 cars and 1,300 locomotives.

This seeming delay in delivering the big locomotives was part of the plan. Gen. Bernard Montgomery stated flatly that he would have no steam locomotives in his area of

EUROPEAN COUPLERS. American car and locomotive manufacturers were forced to build their equipment to European standards when we first became the railroad arsenal of the United Nations. Couplings, for instance, are of the screw type. The platelike projecting faces are buffers, backed by springs, that absorb the shock as rolling stock jounces back and forth during a trip. In America we use a coupler which is automatic and simple, and serves the same purpose. In addition, the U. S. lines have a standard coupling height of 34½ inches, while on the continent it may run as low as 20 inches





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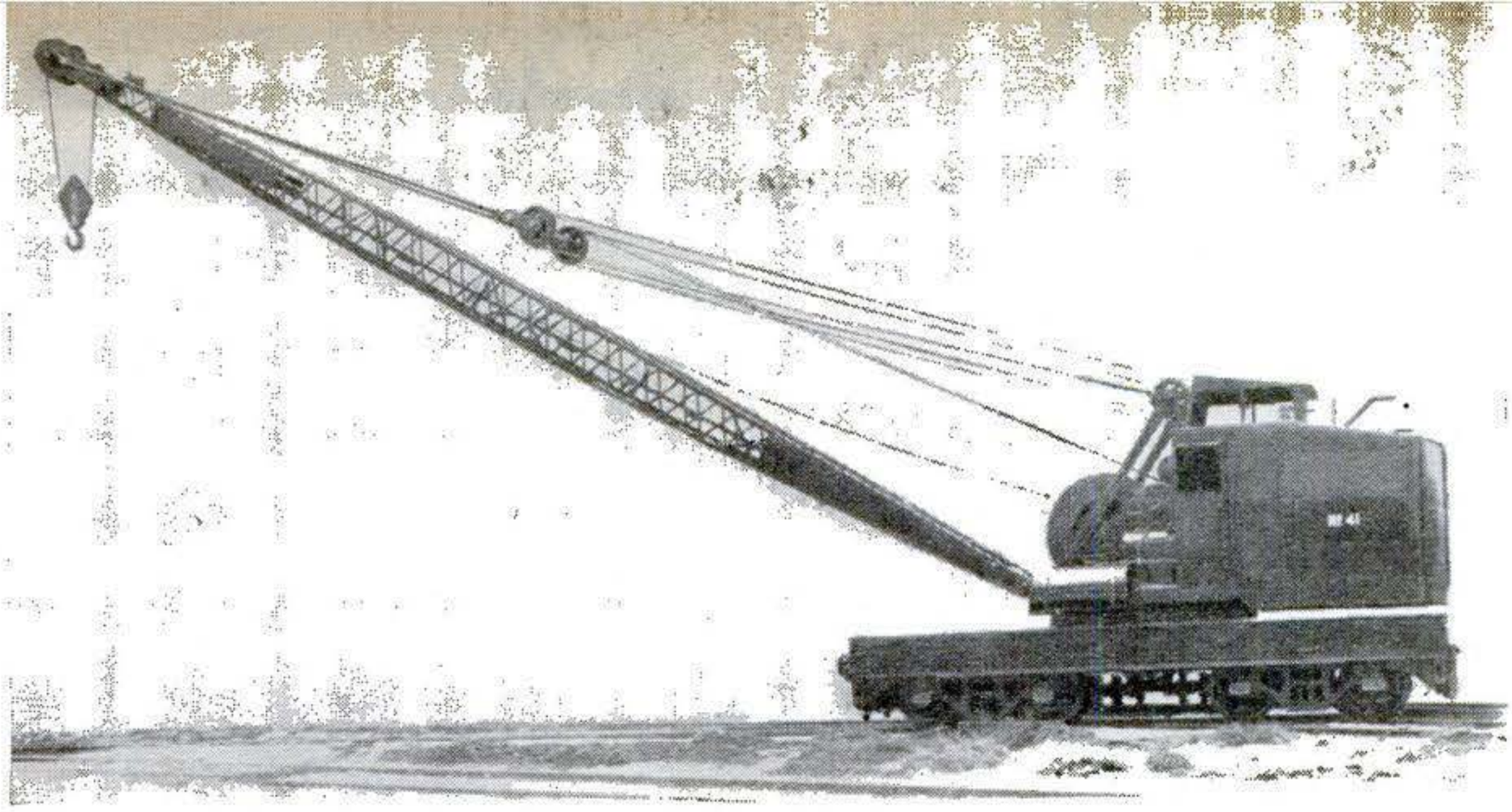
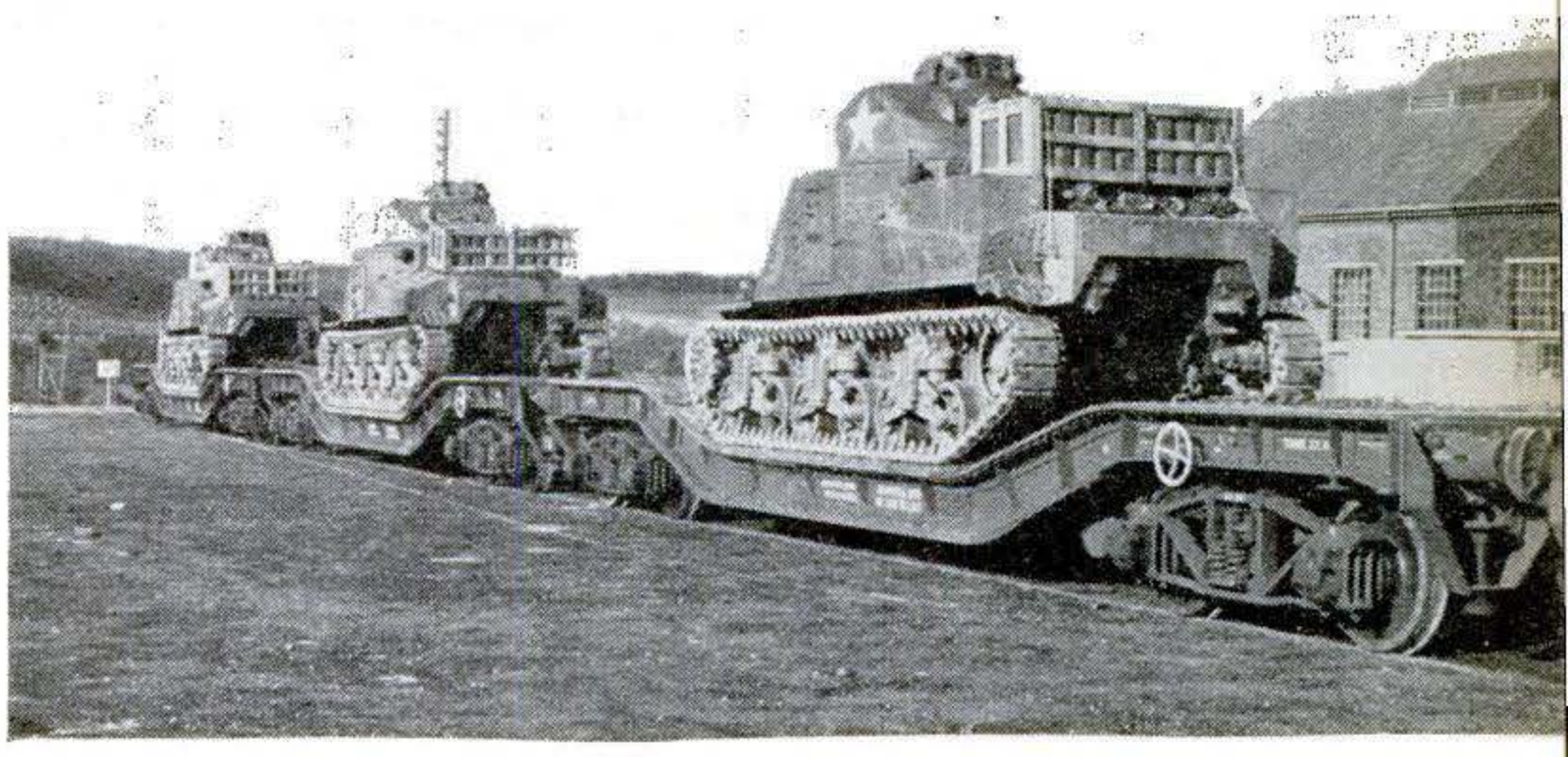


SELF - PROPELLED WRECKER. Railroad wreckage left by Allied strafing planes and German demolition has to be cleared quickly. So we have sent large numbers of these Diesel-propelled wrecking cranes overseas to lend a hand in keeping 'em running



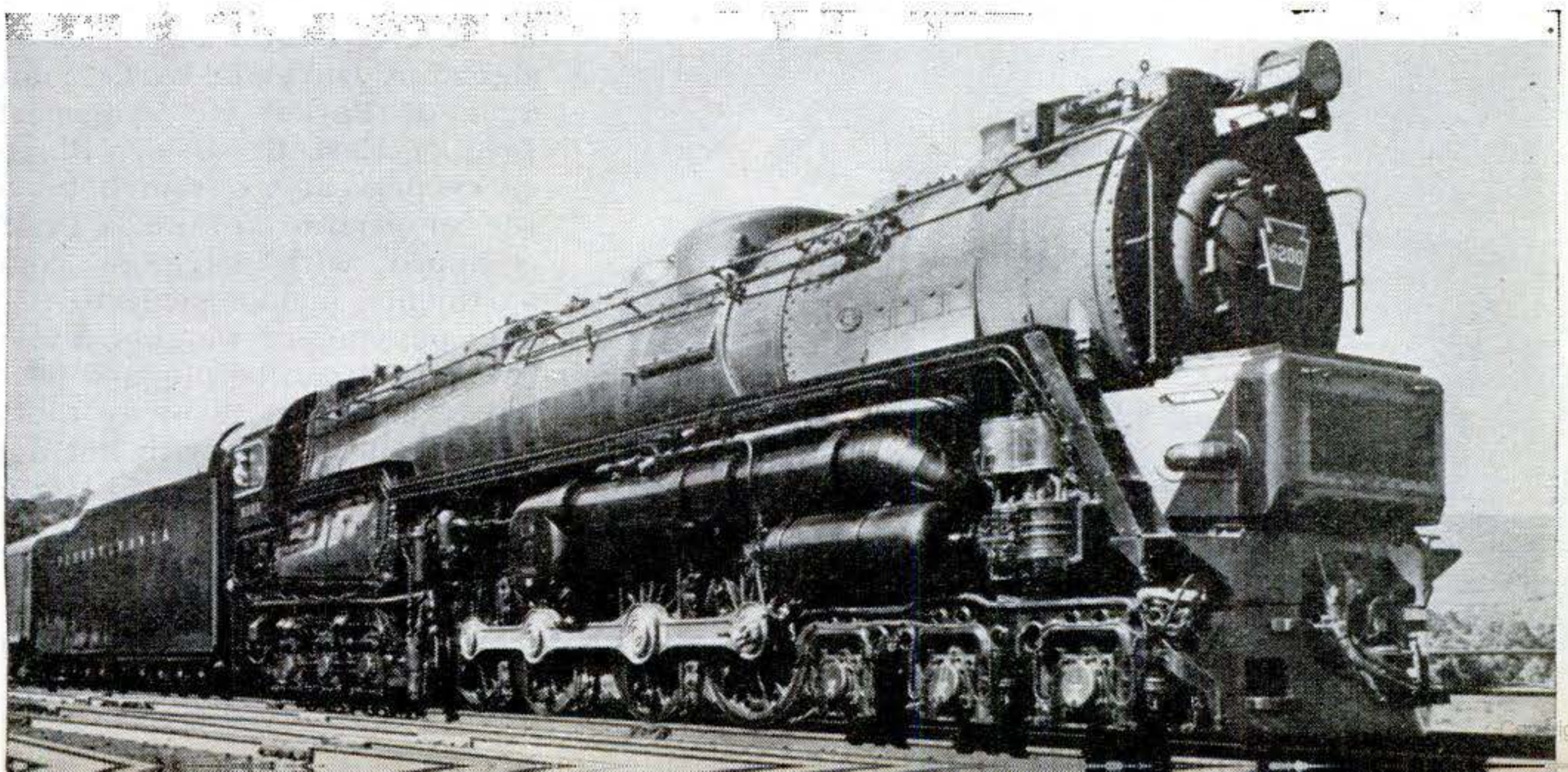
TANK CARRIERS. Developed to meet a specific war demand, these special-bed flatcars conform snugly to the outline of General Grant tanks, holding them securely en route to battle fronts. Known as Barnell cars, some of them are shown at an ordnance depot in England

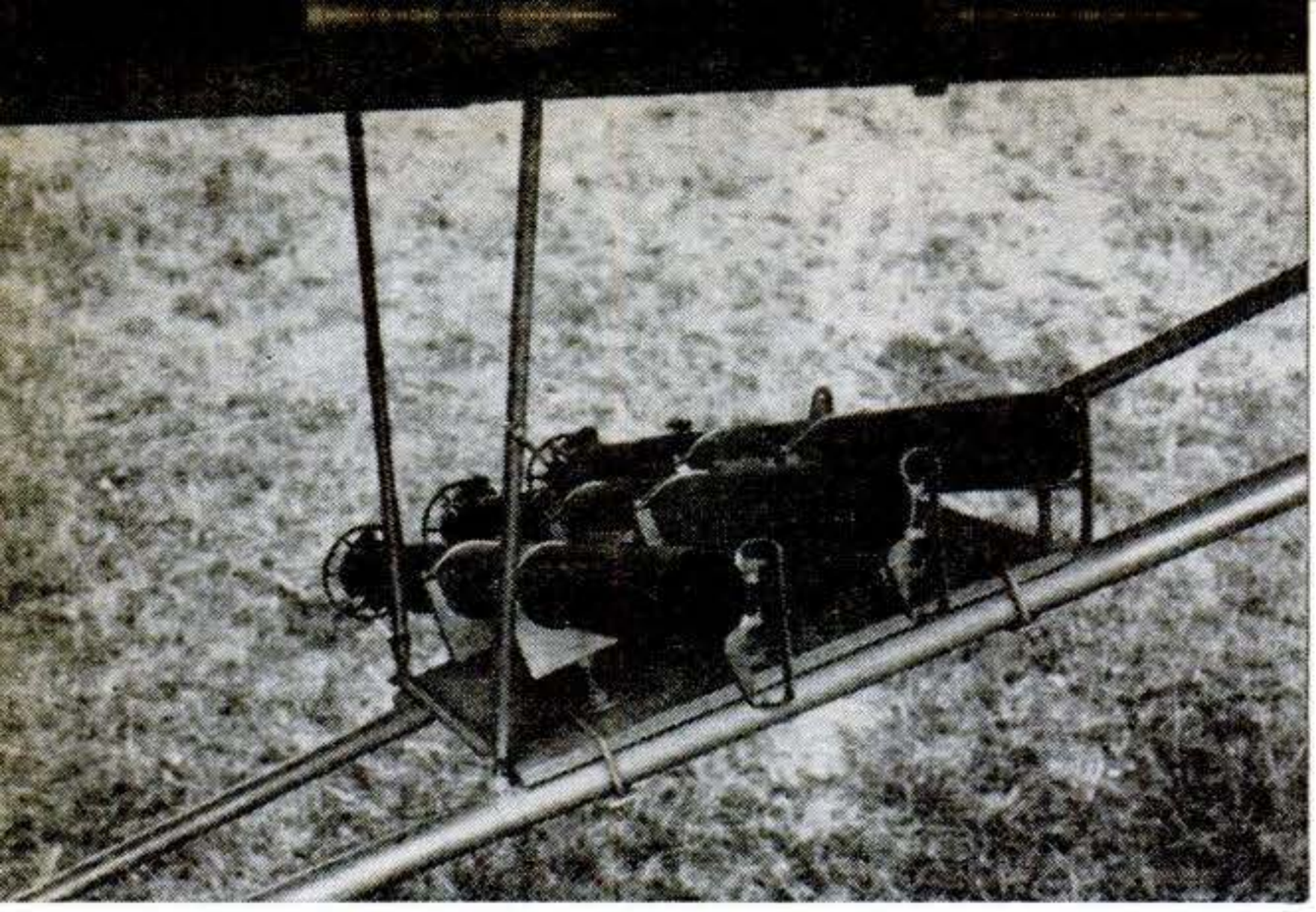
operations during the first critical weeks. The railroad crews, he complained, were always right up behind the front lines, and the smoke and steam made targets for enemy artillery. So they used Diesels.

The Second Battle of France could not have been fought without the Transportation Corps' cars and locomotives. Of the 30,000 locomotives the French railroads normally operated, less than 4,000 were found and most of these were in very bad shape.

The campaign in France lent eloquent testimony to the role of the railroad in war. In the 81 days that the "Red Ball Express," the truck supply route between Normandy and Paris, operated while the French rail lines were being refurbished, it toted a half million tons of supplies. That much is being carried every 23 days now by the rails supplying the front. *(Continued on page 220)*

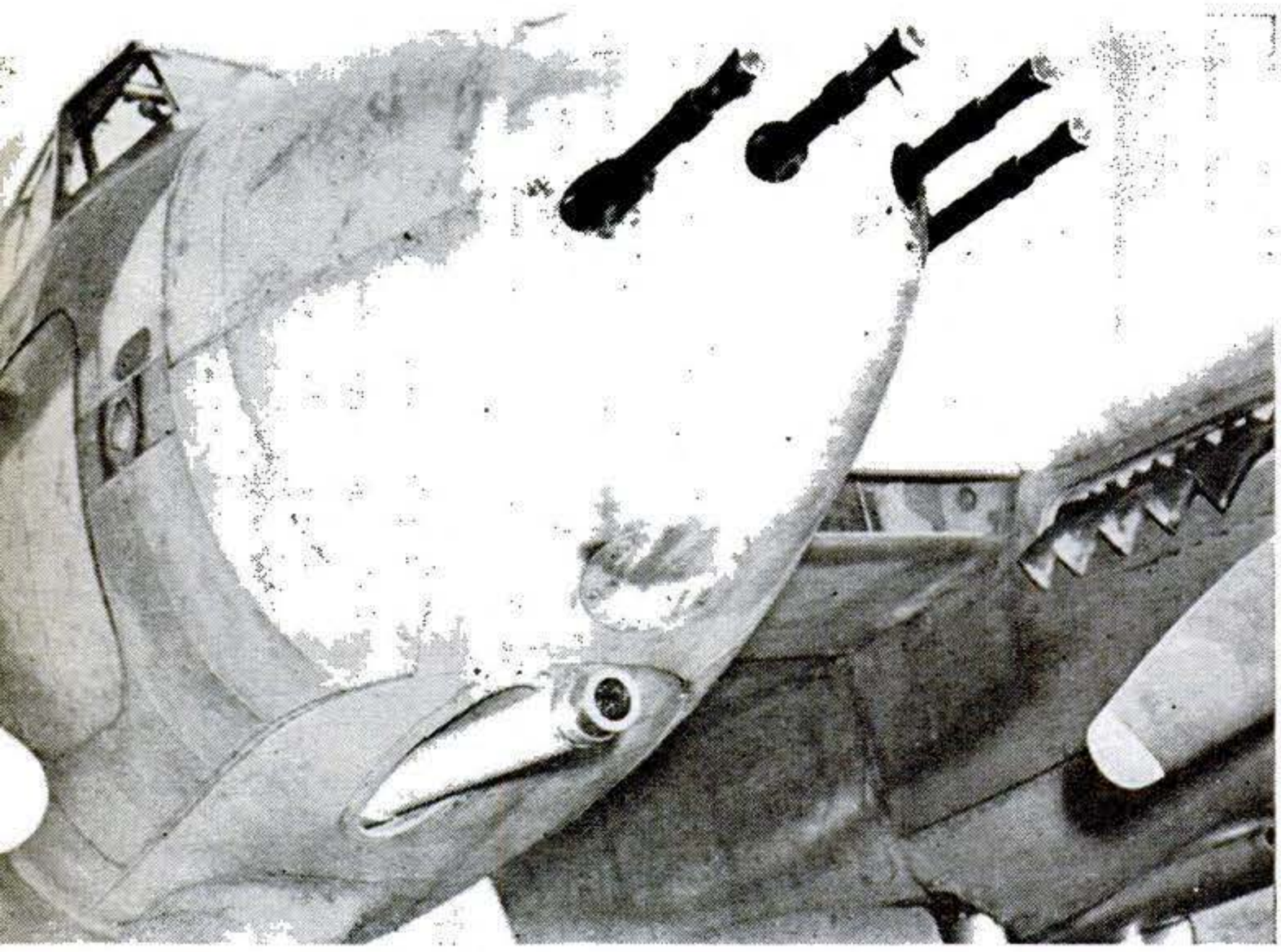
LOCOMOTIVE OF TOMORROW? The war has brought about an acceleration in the development of the locomotive, as it has in so many other technical fields. This Pennsylvania Railroad mammoth may be a foretaste of the future. It is powered by a steam turbine instead of pistons, cylinders, and driving rods. The engine and tender have a combined weight of almost 500 tons and an overall length of 123 feet



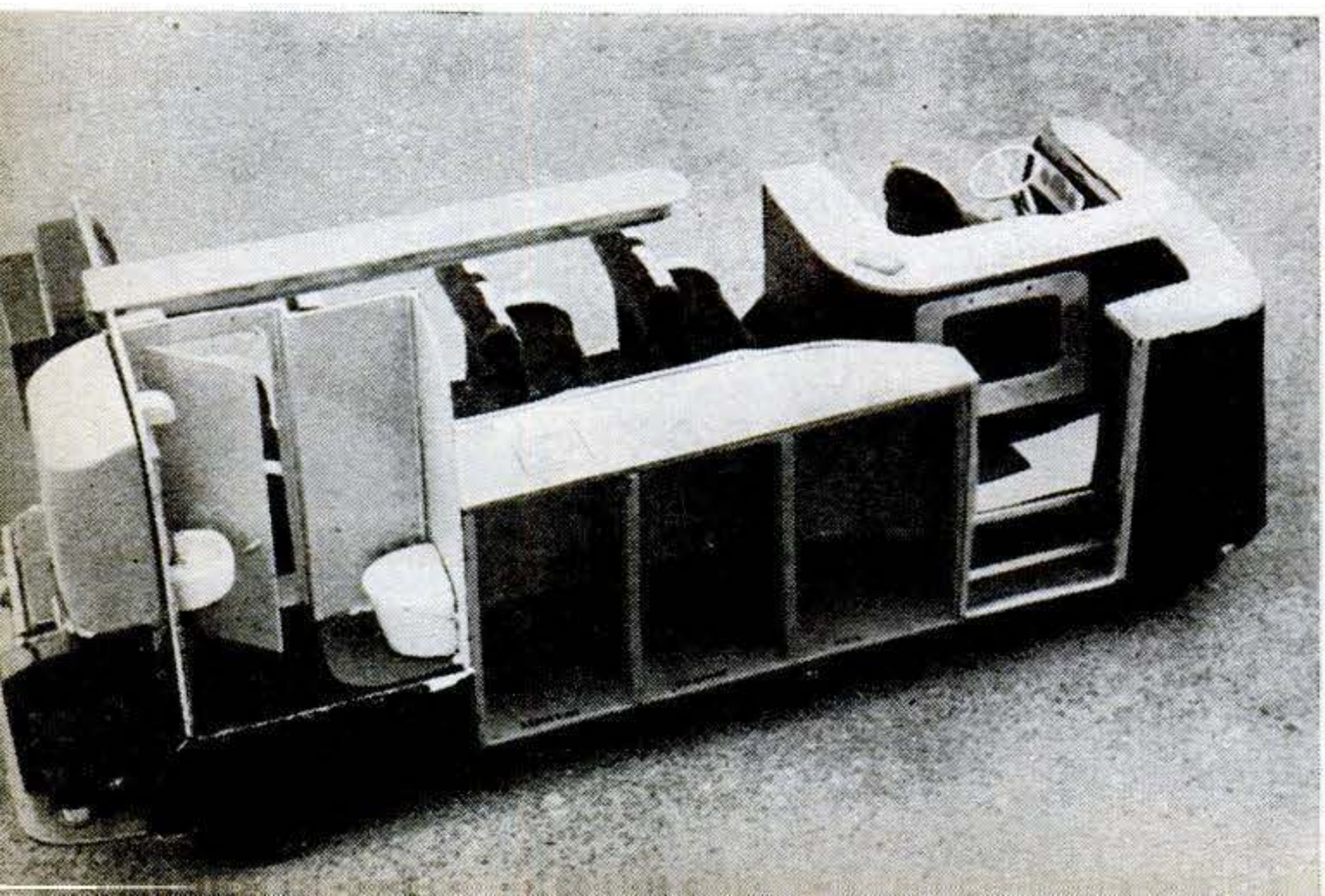


PIPER CUB TANK BUSTER. Maj. Charlie Carpenter, of the Armored Command, got tired of seeing enemy tanks scurrying around below while he spotted artillery hits from his "grasshopper" plane. So, with the assistance of the Ninth Air Force Service Command and an associate in Ordnance, he equipped the Cub with bazookas, and went to work on the Germans. Under each of the wings was mounted a battery of three of the weapons, loaded and ready for firing by means of a cord pulled by the pilot. The prey was sized up from a high altitude, and, since the enemy believed that the pilot was concerned only with artillery spotting, they did not notice the bazookas inconspicuously located under his wings. When he had picked his target, he spiraled down and swooped in just above the treetops for the kill.

The first day, Carpenter knocked out one Tiger tank with each battery, and the latest available report shows his total to be 14. The photograph at the left is a muzzle-end view showing how three of the rocket hurlers are mounted on the struts of a Piper Cub. All three bazookas on one side are fired by a jerk on a lanyard, shaking the little ship like a fever chill.



NEW WALLOP is carried by latest version of the British Mosquito, the Mark XVIII, which carrries a six-pounder that pokes out its muzzle from beneath the nose and fires a shot every second. The new cannon has been so effective against U-boats that the Germans have had to adopt new tactics. Its accuracy was proved when a Mosquito pilot, attacked by 12 JU-88's, blew one of them to pieces at a one-mile range. The six-pounder is about the equivalent of the 75-millimeter gun carried by our B-25 Mitchell bomber. In addition to this, the Mark XVIII carries four .303 machine guns.



EFFICIENCY BUS has been designed by Oliver L. Parks, manager of Parks Air Transport, Inc., of East St. Louis, Ill., to carry passengers from hotel to feeder-airline plane. It is equipped with baggage compartments, a floor scale to register passengers' weights, a telephone that can be plugged in at the terminals, a two-way radio, and a toilet room with hot and cold running water. (Model shown here has its roof and sides removed.)

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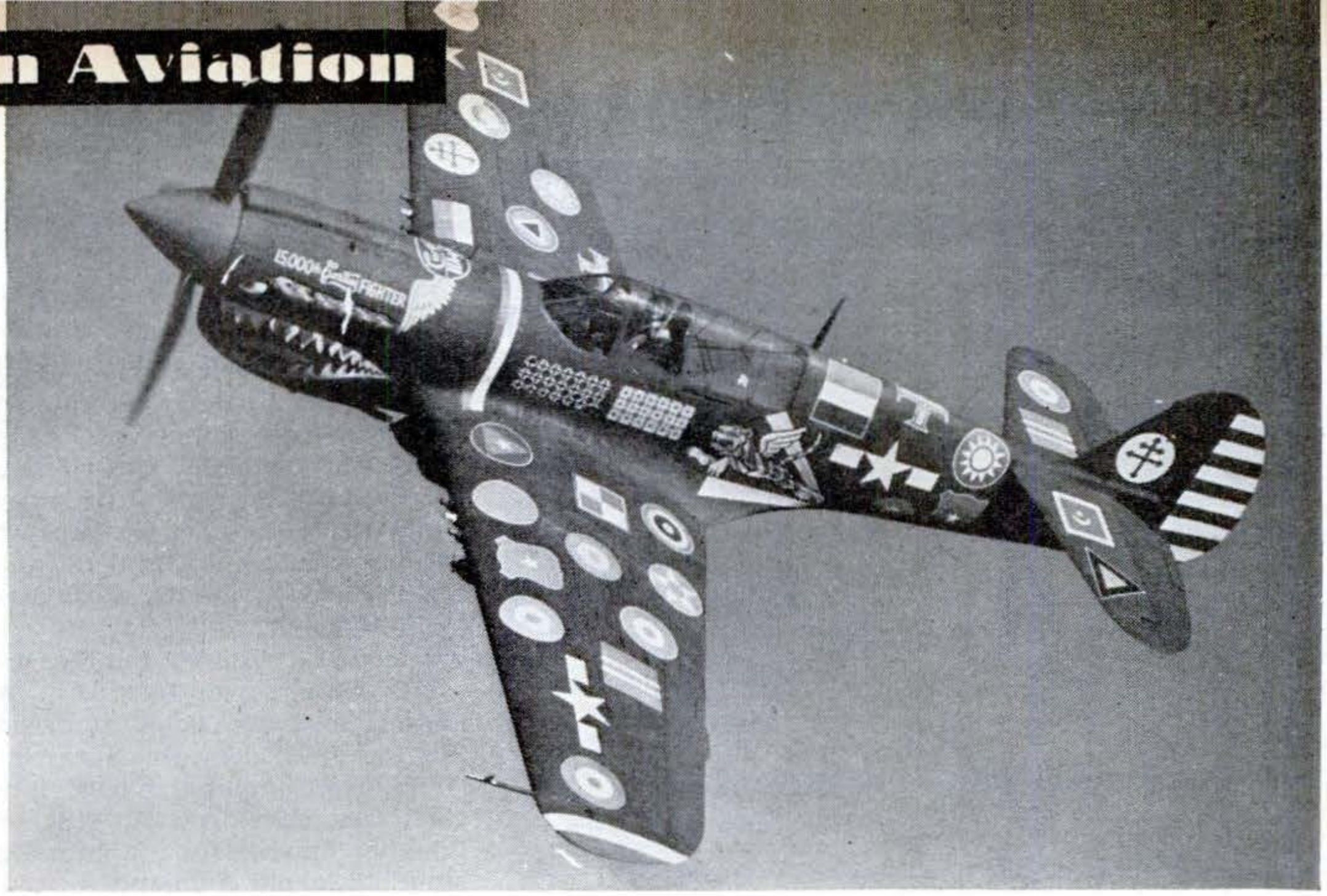
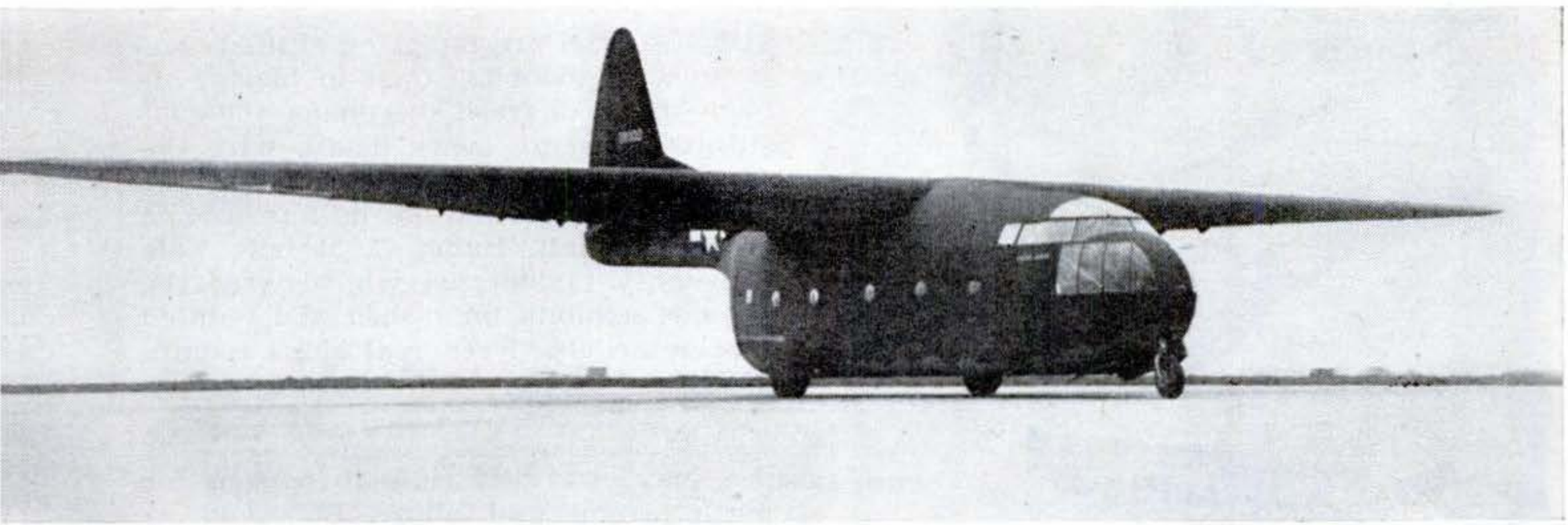
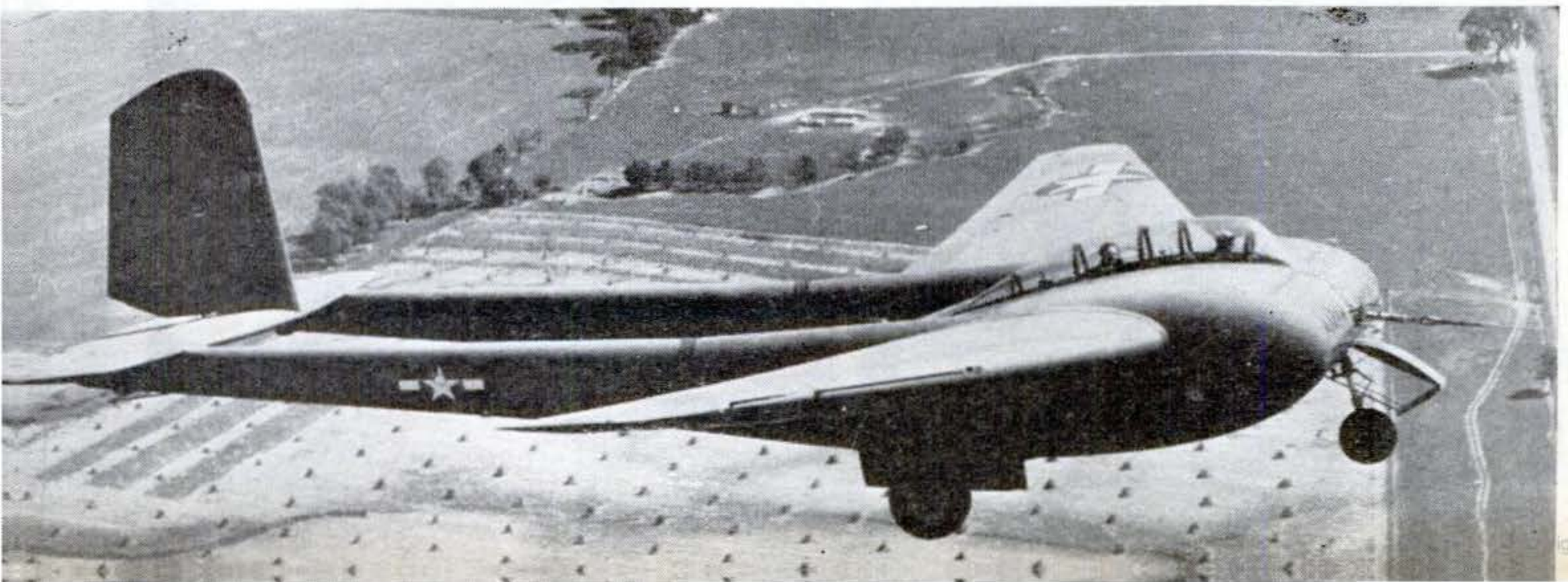


15,000TH FIGHTER to be turned out by the Curtiss-Wright Corp. for the United Nations, this P-40 Warhawk wears the insignia of the 28 Allied air forces in which Curtiss-built fighters have served. Prominently displayed are the markings of Maj. Gen. Claire Chennault's Flying Tigers, with which the P-40's won undying fame in China.

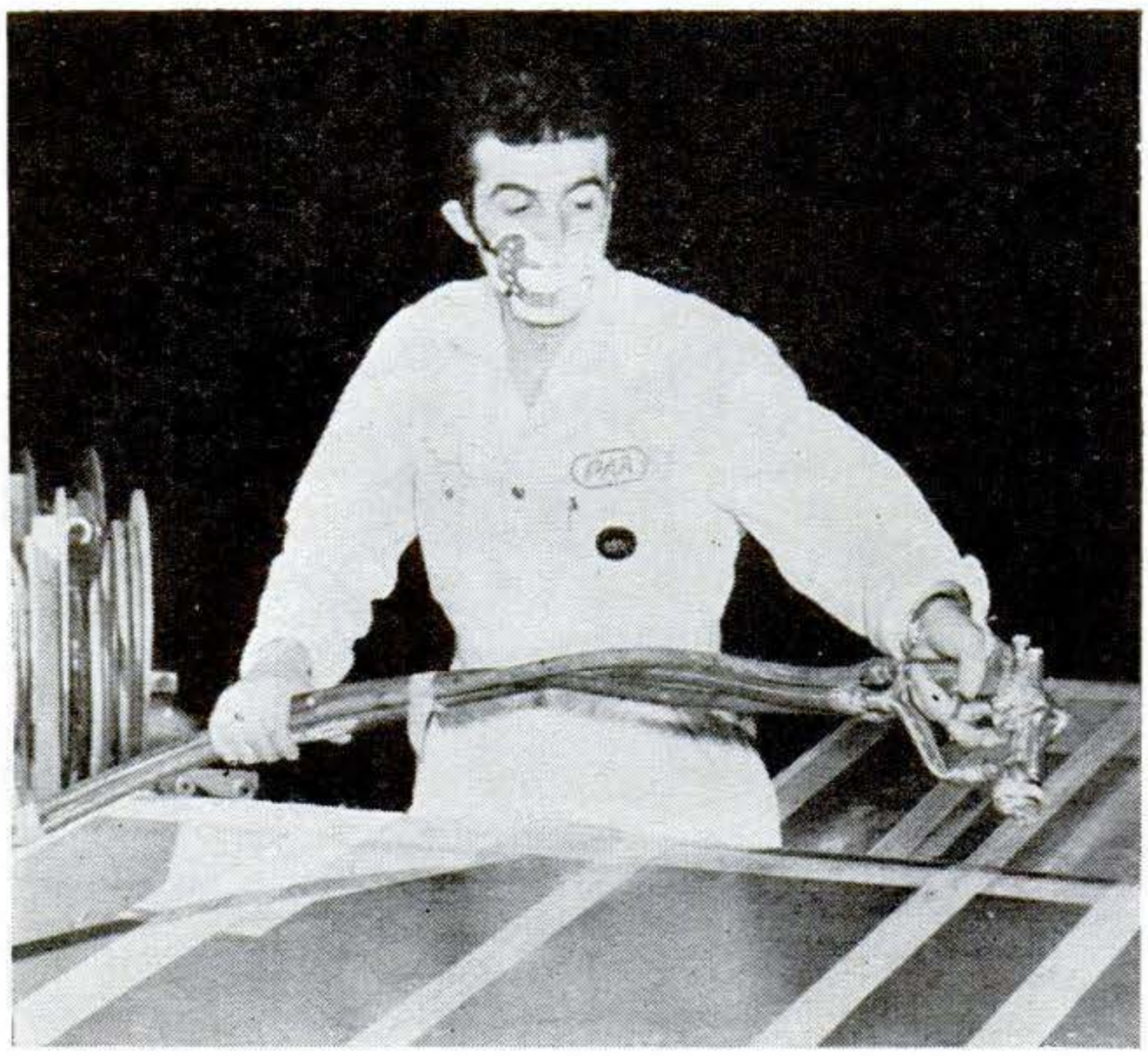


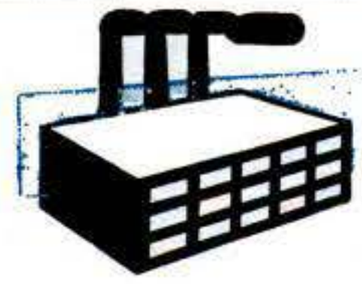
GIANT GLIDER, CG-10A, can carry 42 fully armed men or six tons of freight. Designed and built by the Laister-Kauffman Aircraft Corp., St. Louis, Mo., it has a span of 105 feet, almost two feet greater than that of the Flying Fortress.

TWIN TAIL BOOMS were used for the first time in U. S. gliders in the CG-16, shown below. Craft was designed by Hawley Bowlus, Los Angeles, Calif., and built by General Airborne Transport, Inc. Span is 91 feet 9 inches.



March of Science



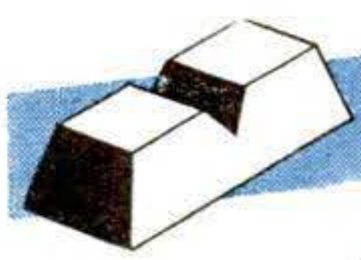


INDUSTRY

THINNING LACQUER WITH HEAT now obviates mixing it with expensive thinners, to bring it to just the right consistency for application with a spray gun. Wartime use of the process speeds coating of gliders and light plywood planes with airplane "dope," as at left, by reducing the required number of coats from seven to three. A major postwar field, foreseen for the method by the Sherwin-Williams Company, whose laboratories developed it, will be tougher finishes for automobiles and household appliances.

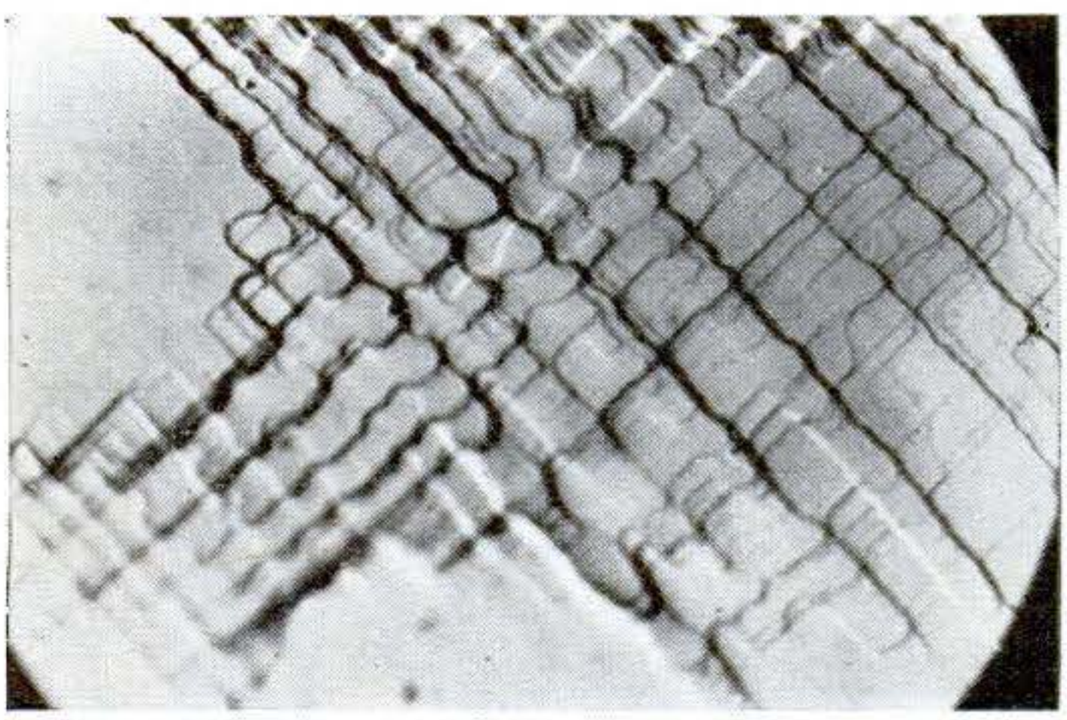
NATURAL HISTORY

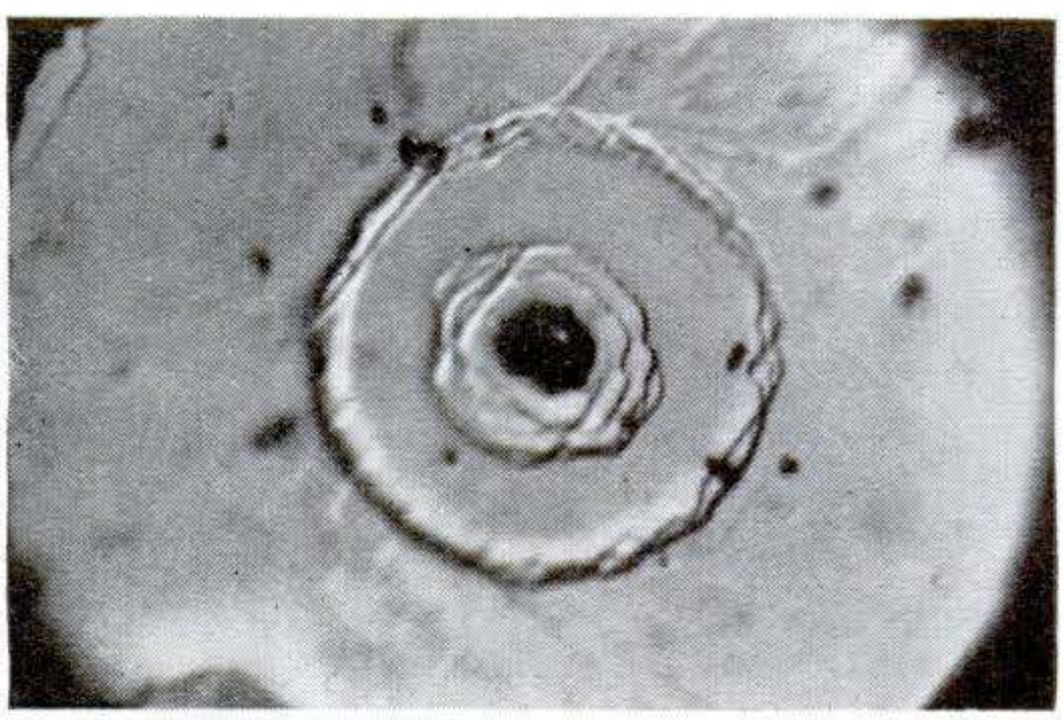
RUBBER FISH are replacing stuffed ones in museum exhibits. Cast in plaster-of-Paris molds of fresh specimens, the substitutes preserve every detail, with the advantage over mounted skins that the body does not shrink, nor do fins become brittle. At left, Ralph C. Morrill, Yale University taxidermist who devised the scheme, exhibits unfinished and painted rubber models. Even real skins require painting to restore faded natural colors.



METALLURGY

FRACTOGRAPHY. Odd patterns of broken metal fragments, studied for the first time under powerful microscopes, may yield new clues to reasons for strength, fatigue, and failure. Photos below show fractured 50-percent silicon-iron alloy, magnified 1,000 times. Familiar "terrace pattern" of facets at left contrasts with concentric circles at right, surrounding a foreign particle of silicon dioxide.





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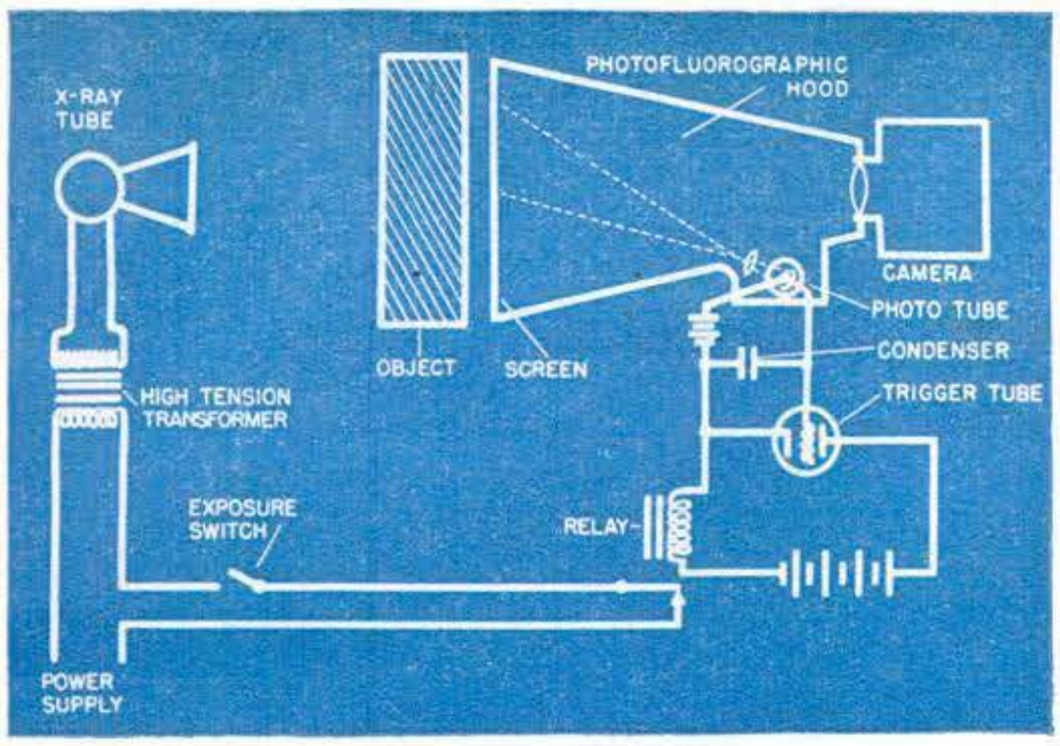
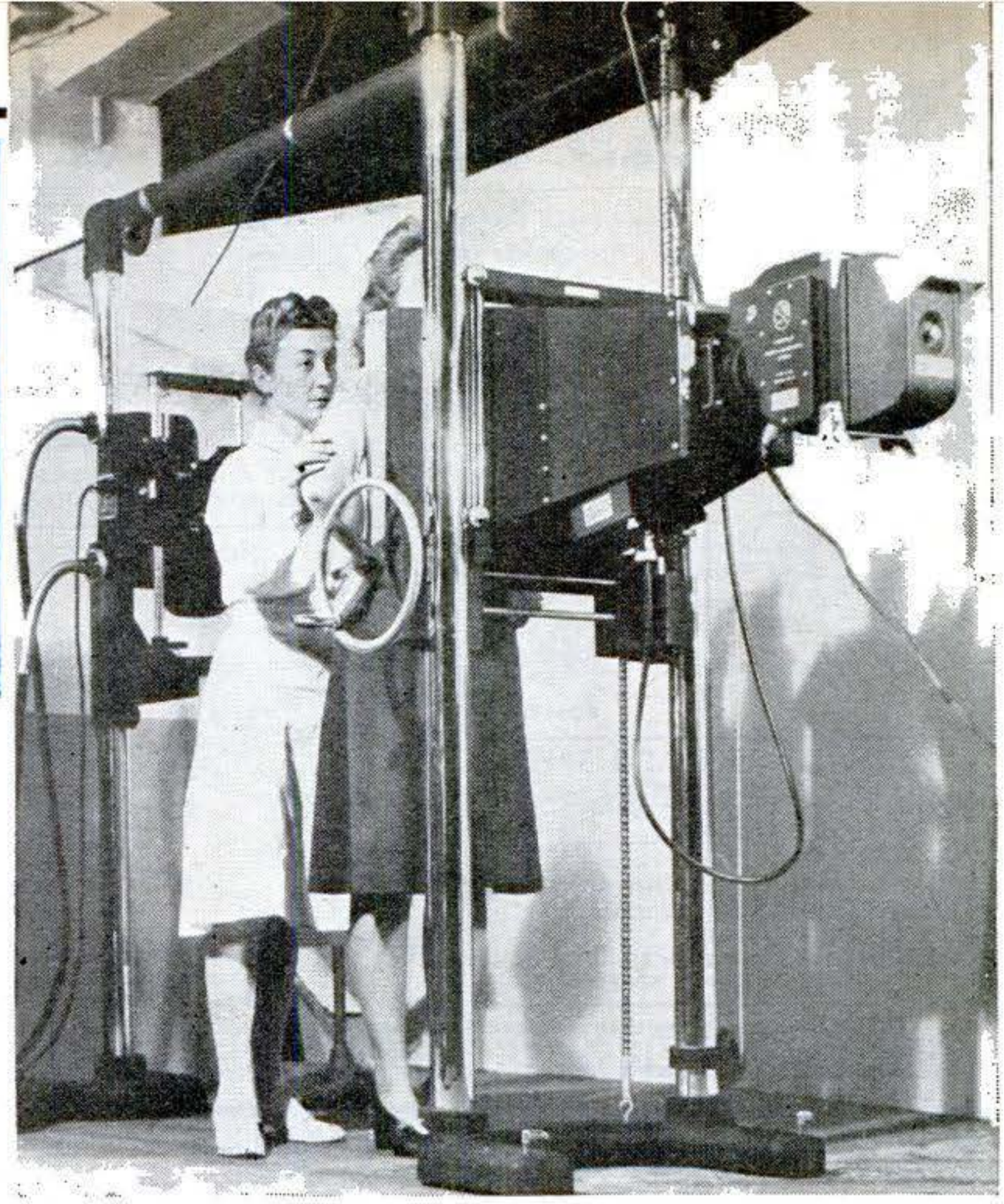


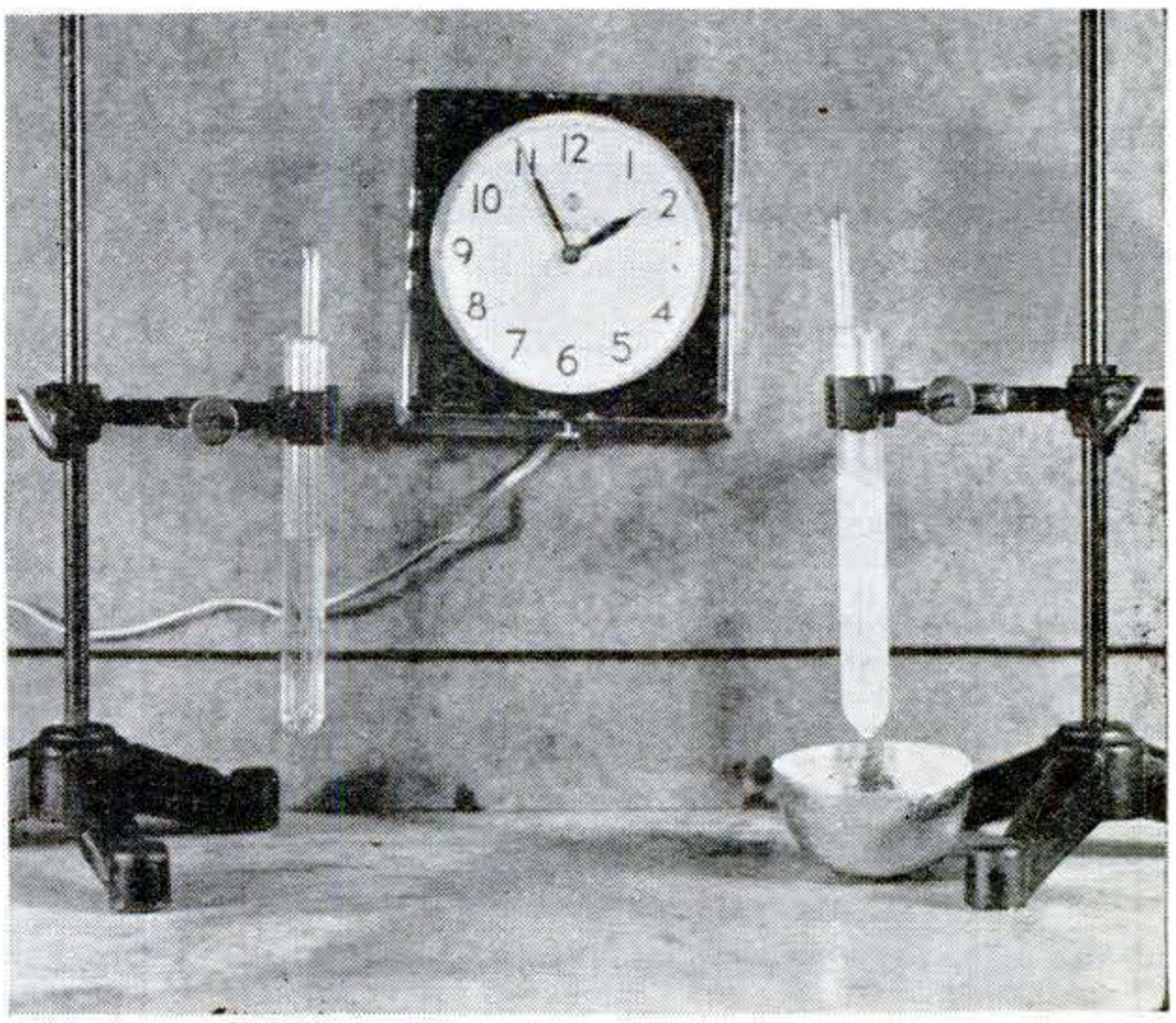


ELECTRONICS

X-RAY TUBERCULOSIS CHECK. An exposure meter for X-ray pictures, developed by Westinghouse engineers, automatically compensates for individual differences in body thickness and tissue density. Built into an outfit for examining industrial workers for signs of tuberculosis, it permits handling 1,000 subjects a day, twice the number previously possible. Consequent reduction in time off from work encourages progressive employers to arrange health examinations for their employees, to the mutual advantage of both. The X-rays frequently reveal unsuspected cases of "T.B." Photo and diagram above show the complete apparatus and how it works.

CHEMISTRY

CHEMICAL-RESISTING GLASS that defies even hydrofluoric acid, which etches and dissolves ordinary glassware, has been announced by the American Optical Co., Southbridge, Mass. An immediate use will be in containers for the industrially important acid, which has hitherto had to be handled in vessels of platinum, lead, rubber, or paraffin. Other applications include safety goggles and helmets for chemical workers. Photo at lower left shows ordinary glass frosted, new glass clear, in windows of helmet brushed with hydrofluoric acid; at right, test tube of special glass is unaffected by the acid, while bottom of ordinary test tube has been eaten through. To make the impervious product, a white powder called phosphorus pentoxide replaces sand in the conventional glass formula of sand, lime, and soda.



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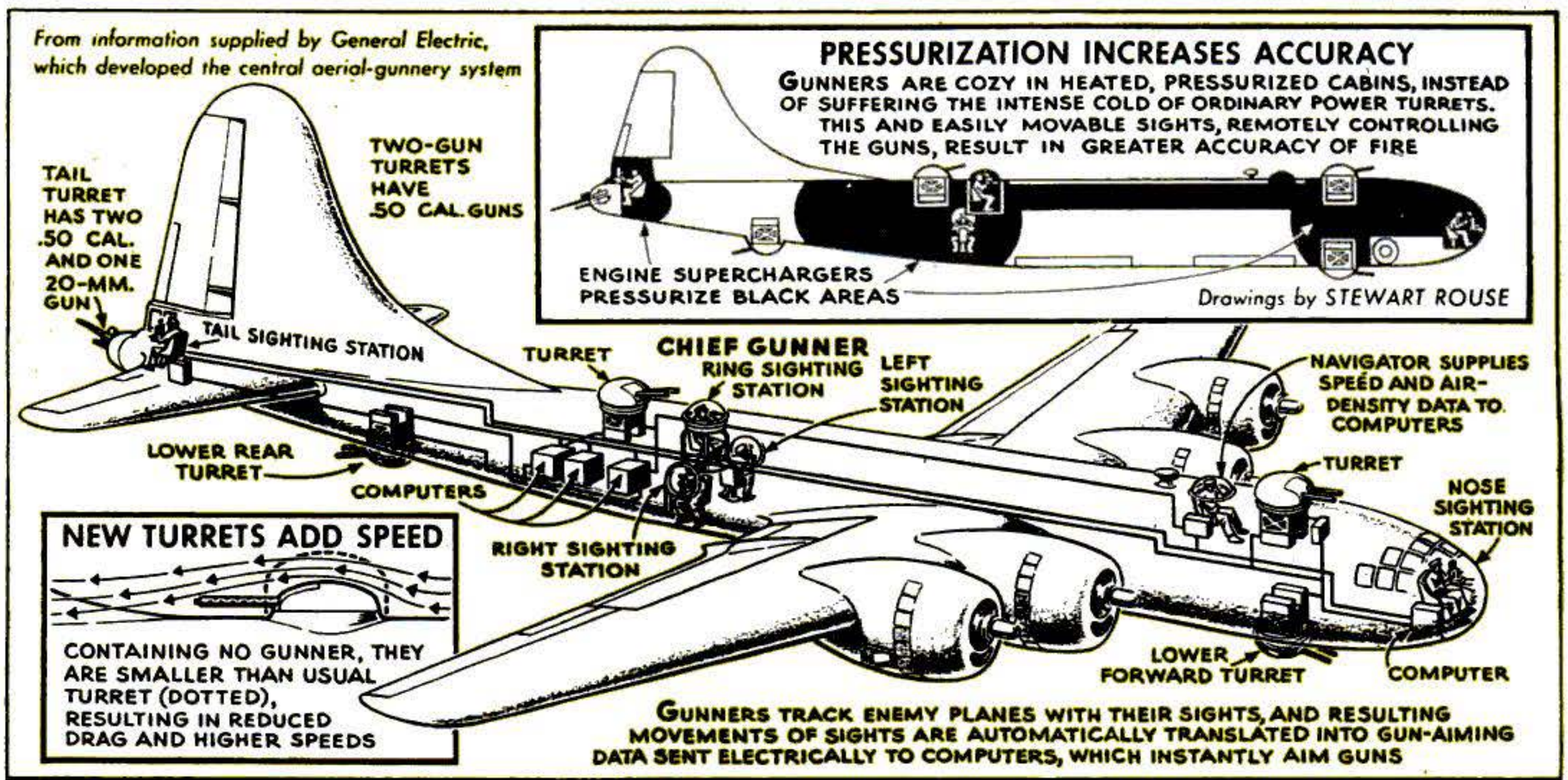
Secrets of B-29's Gun Controls

From information supplied by General Electric, which developed the central aerial-gunnery system

PRESSURIZATION INCREASES ACCURACY

GUNNERS ARE COZY IN HEATED, PRESSURIZED CABINS, INSTEAD OF SUFFERING THE INTENSE COLD OF ORDINARY POWER TURRETS. THIS AND EASILY MOVABLE SIGHTS, REMOTELY CONTROLLING THE GUNS, RESULT IN GREATER ACCURACY OF FIRE

Drawings by STEWART ROUSE



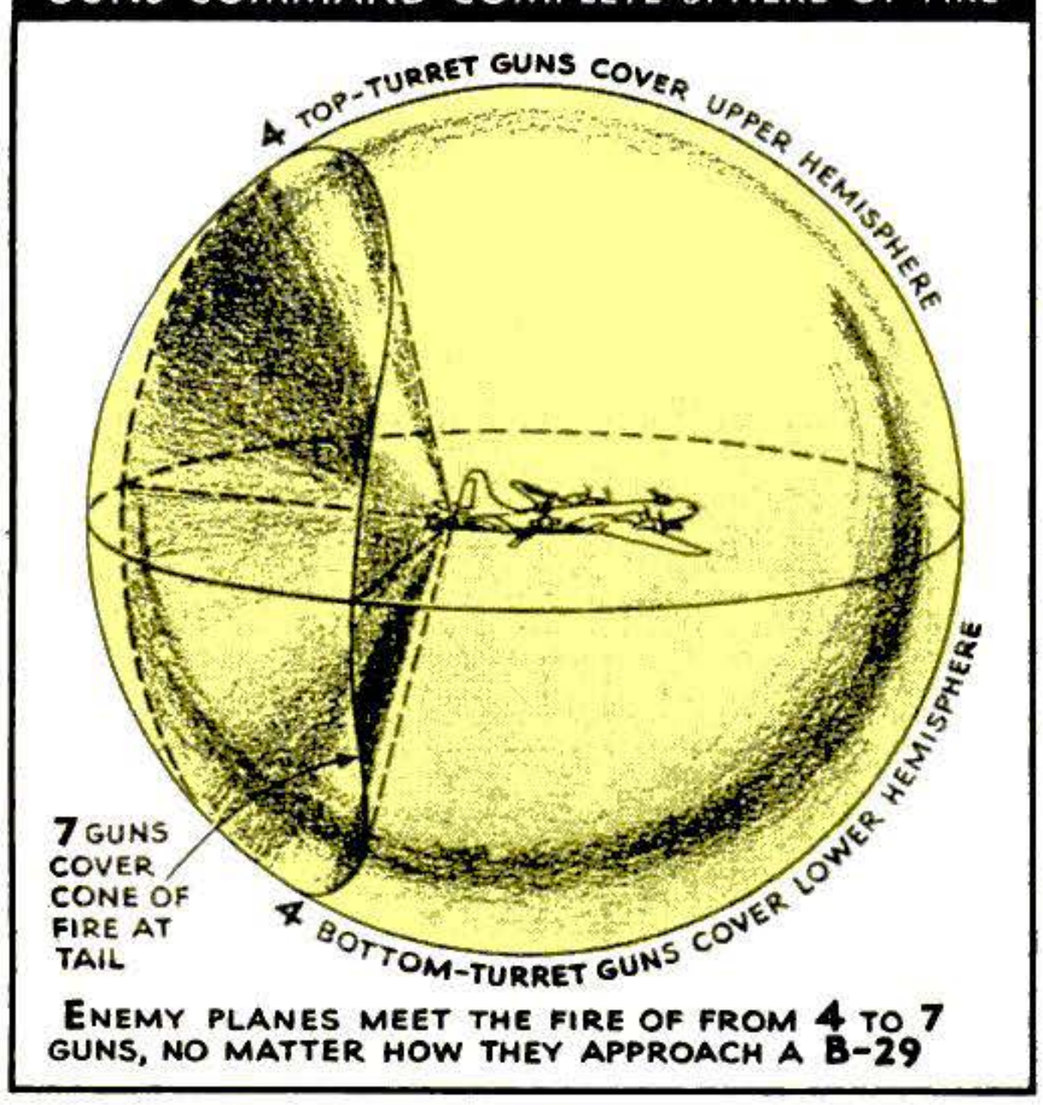
NEW TURRETS ADD SPEED

CONTAINING NO GUNNER, THEY ARE SMALLER THAN USUAL TURRET (DOTTED), RESULTING IN REDUCED DRAG AND HIGHER SPEEDS

GUNNERS TRACK ENEMY PLANES WITH THEIR SIGHTS, AND RESULTING MOVEMENTS OF SIGHTS ARE AUTOMATICALLY TRANSLATED INTO GUN-AIMING DATA SENT ELECTRICALLY TO COMPUTERS, WHICH INSTANTLY AIM GUNS

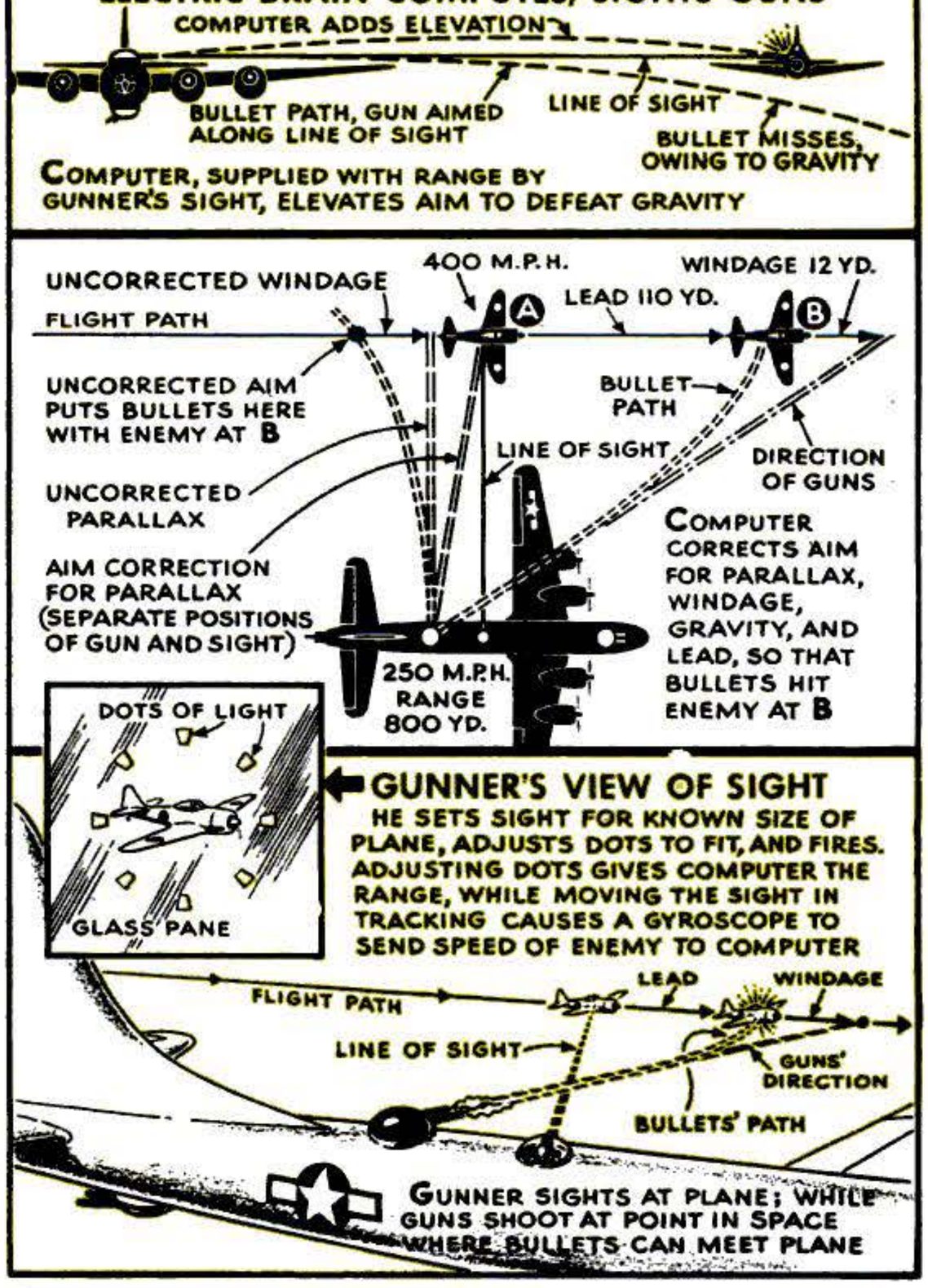
SUPERFORTRESS GUNS ARE FIRED LIKE BATTLESHIP'S

GUNS COMMAND COMPLETE SPHERE OF FIRE



ENEMY PLANES MEET THE FIRE OF FROM 4 TO 7 GUNS, NO MATTER HOW THEY APPROACH A B-29

ELECTRIC BRAIN COMPUTES, SIGHTS GUNS

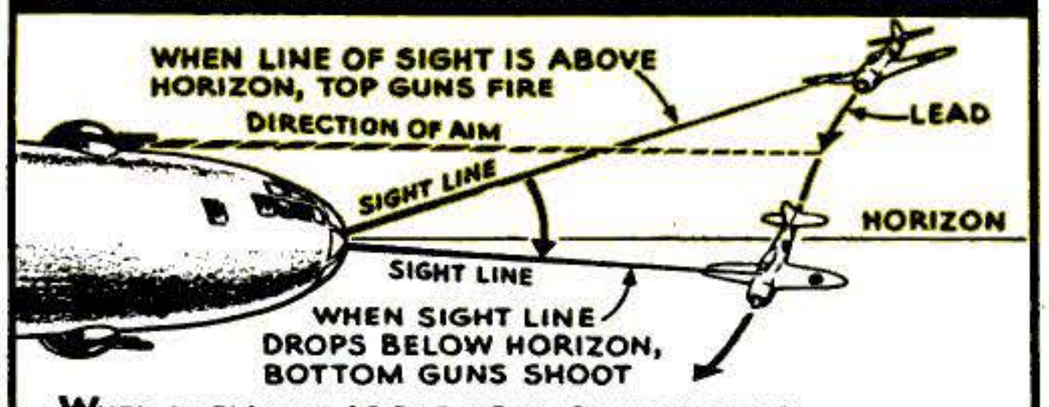


GUNNER'S VIEW OF SIGHT

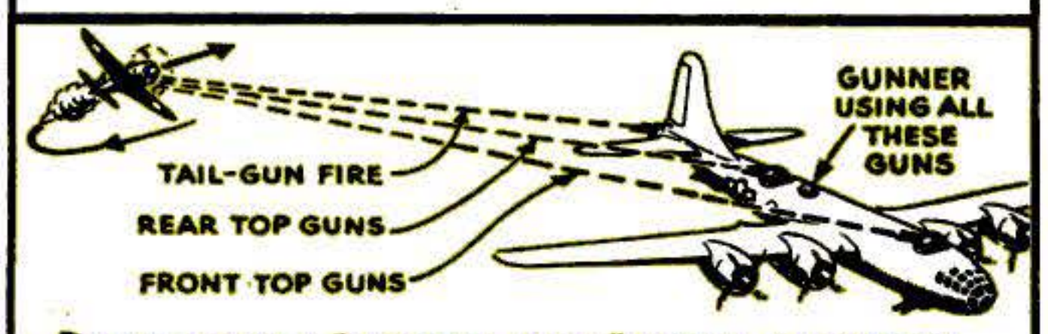
HE SETS SIGHT FOR KNOWN SIZE OF PLANE, ADJUSTS DOTS TO FIT, AND FIRES. ADJUSTING DOTS GIVES COMPUTER THE RANGE, WHILE MOVING THE SIGHT IN TRACKING CAUSES A GYROSCOPE TO SEND SPEED OF ENEMY TO COMPUTER

GUNNER SIGHTS AT PLANE; WHILE GUNS SHOOT AT POINT IN SPACE WHERE BULLETS CAN MEET PLANE

BATTERIES AUTOMATICALLY COME INTO PLAY

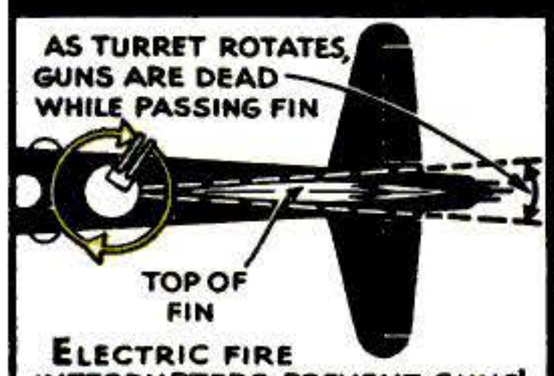


WHEN ENEMY IS ABOVE HORIZON, TOP GUNS FIRE AT HIM; WHEN BELOW, BOTTOM GUNS TAKE OVER



BY PRESSING A "CONTROL SHIFT" SWITCH, A GUNNER CAN CONTROL OTHER GUNS BESIDES HIS OWN, TO THROW A BROADSIDE INTO AN ENEMY. THE CHIEF GUNNER MAKES EFFECTIVE USE OF THIS IN THIS PICTURE

WHY B-29 CAN'T SHOOT ITSELF



ELECTRIC FIRE INTERRUPTERS PREVENT GUNS' FIRING WHEN POINTED AT ANY PART OF PLANE

MECHANICAL CONTOUR FOLLOWER KEEPS GUNS FROM POINTING AT GUNNER—SAFEGUARD AGAINST A SHELL "COOKING OFF" IN HOT GUN

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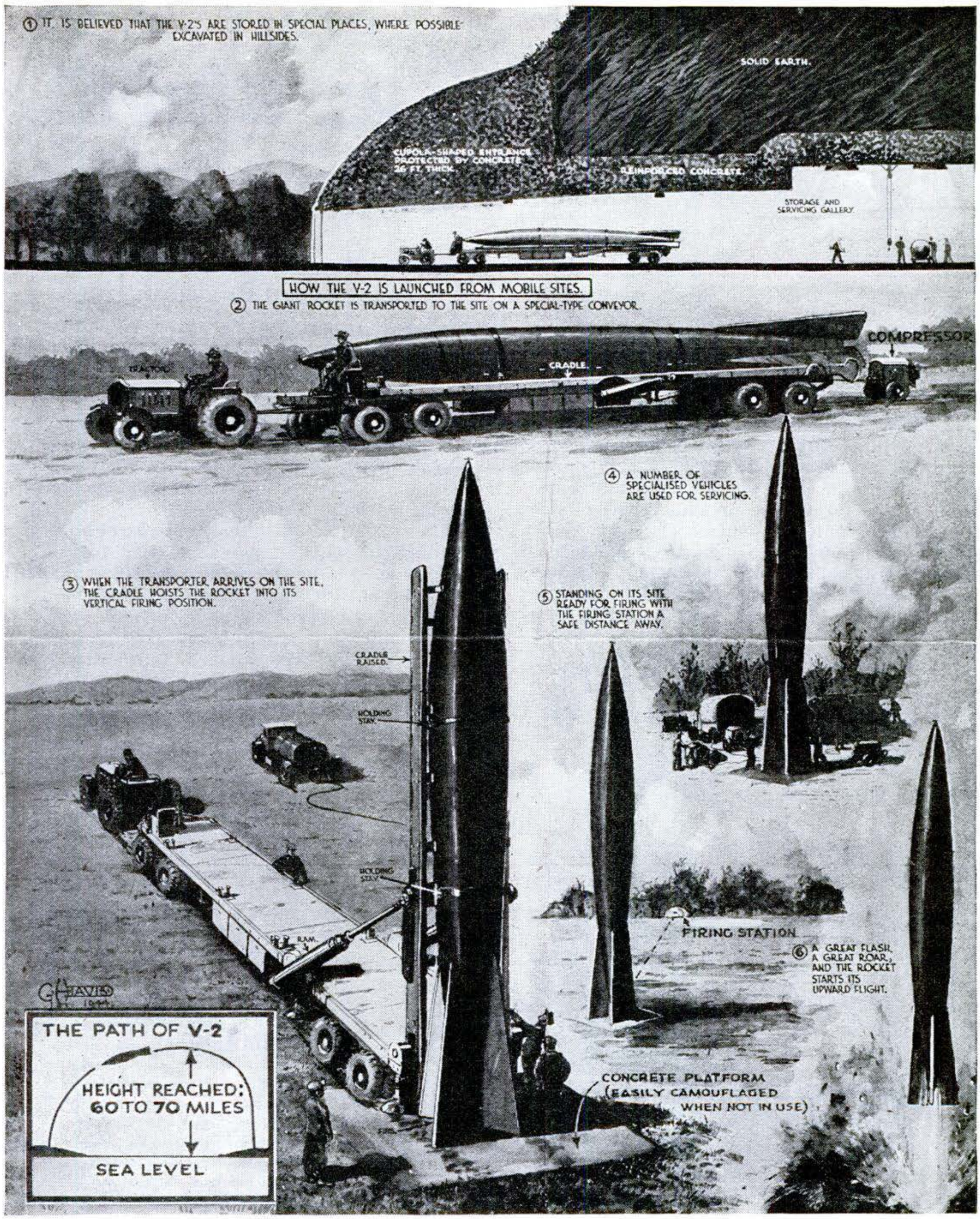

HOW NAZIS LAUNCH V-2 ROCKET

USING an RAF reconnaissance photo made over Peenemunde, Germany, as a guide, artist G. H. Davis drew these sketches for *The Illustrated London News* to show how the Nazis launch the terrifying V-2 rocket. The bombs are stored, it is believed, in huge caves dug in hillsides and heavily reinforced. They are hauled to concrete firing platforms on big trailers and raised to an almost vertical position before being discharged.

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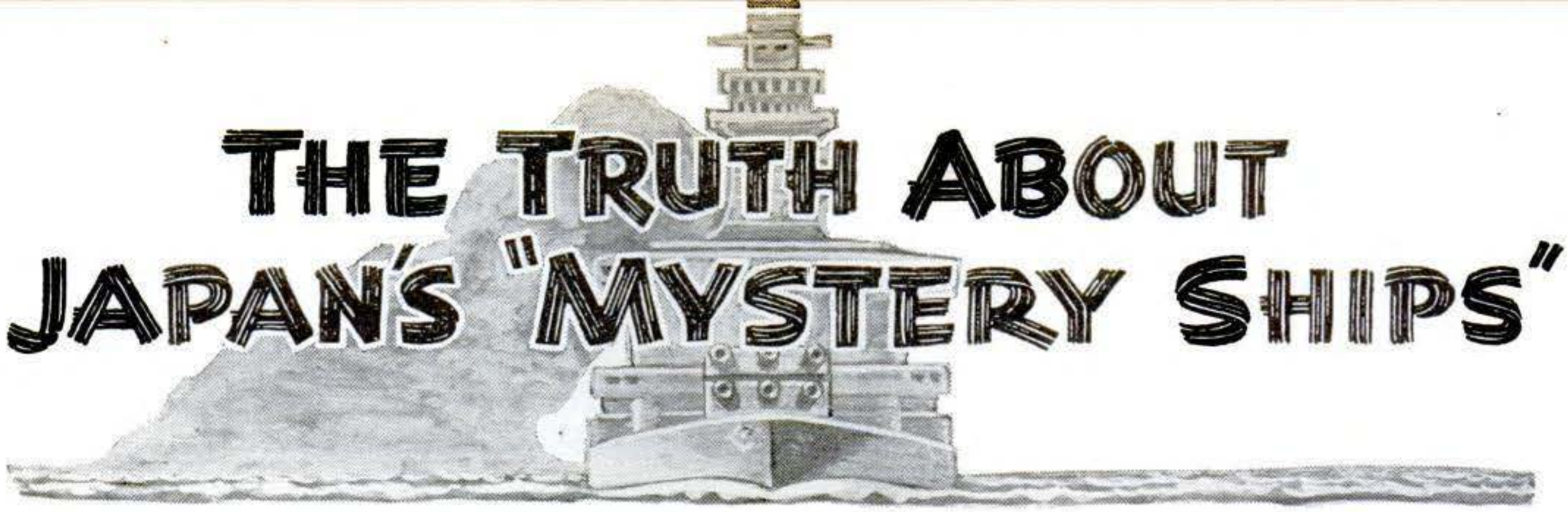


THE TRUTH ABOUT JAPAN'S "MYSTERY SHIPS"

For months we asked, "Where is the Jap navy?" At last it has shown its hand. Here is an analysis of the enemy's seapower.

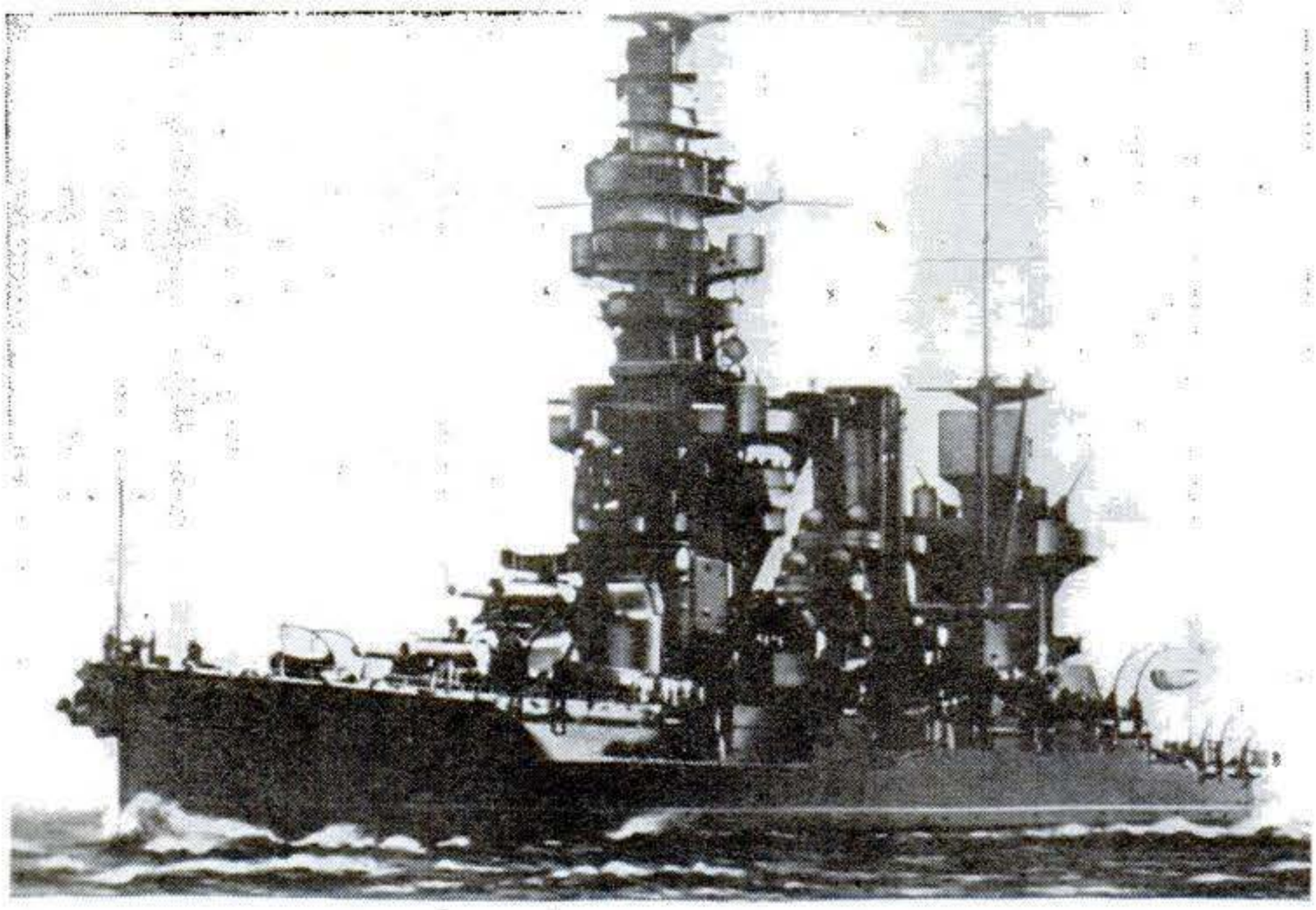
By ALDEN P. ARMAGNAC

TAKING shape beneath concealing roofs of bamboo, in Japanese shipyards, warships of secret design have long inspired wild rumors. At last our advance across the Pacific has forced the mystery craft out of hiding. Now, for the first time, we know what our Navy has to lick—and that information will help it mightily to play its part in the combination of sea, land, and airpower pledged to the destruction of the Japanese Empire.

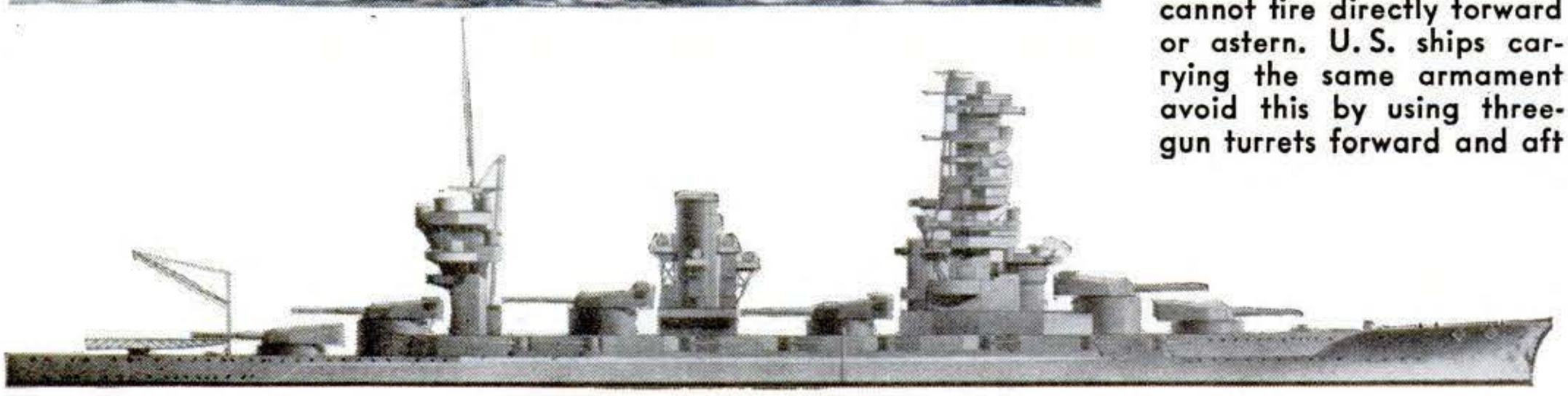
Illustrating the latest in Nipponese battleships, the *Yamato* and *Musashi* first showed themselves in the Second Battle of the Philippines. A photograph snapped from a U. S. Navy plane, while bombs made a shambles of the *Yamato's* superstructure, enables any layman to analyze Japan's most powerful warship class.

Study of the picture indicates a vessel approaching the 45,000-ton size of our *Iowa* class—believed to be the only men-of-war in the world that outclass it, ship for ship. The *Yamato* mounts its main battery of nine big guns, probably 16-inchers, in the first triple turrets to be installed aboard Jap battle-

TWO JAP BATTLESHIPS THAT WILL NOT FIGHT AGAIN



FUSO is one of two enemy battlewagons known to have been sunk in the memorable Second Battle of the Philippines, when the Nipponese navy finally came out for a showdown—and got it. Note the pagoda-like superstructure, typical of all except the latest Jap battleships



YAMASHIRO, a sister ship of the Fuso, also went to the bottom in the same engagement. The drawing below shows the arrangement of the twelve 14-inch guns in six two-gun turrets. The masked central turrets cannot fire directly forward or astern. U. S. ships carrying the same armament avoid this by using three-gun turrets forward and aft

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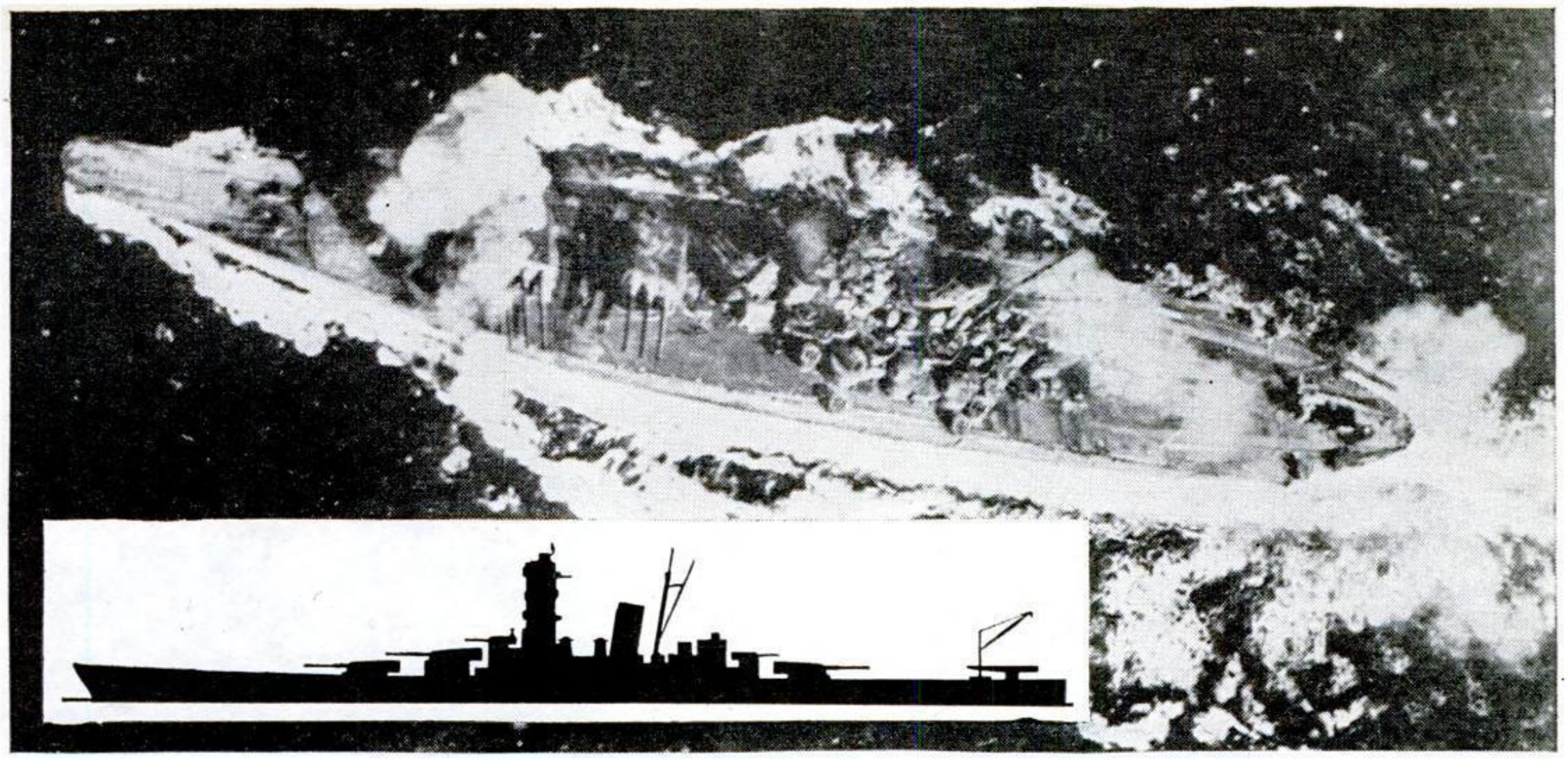
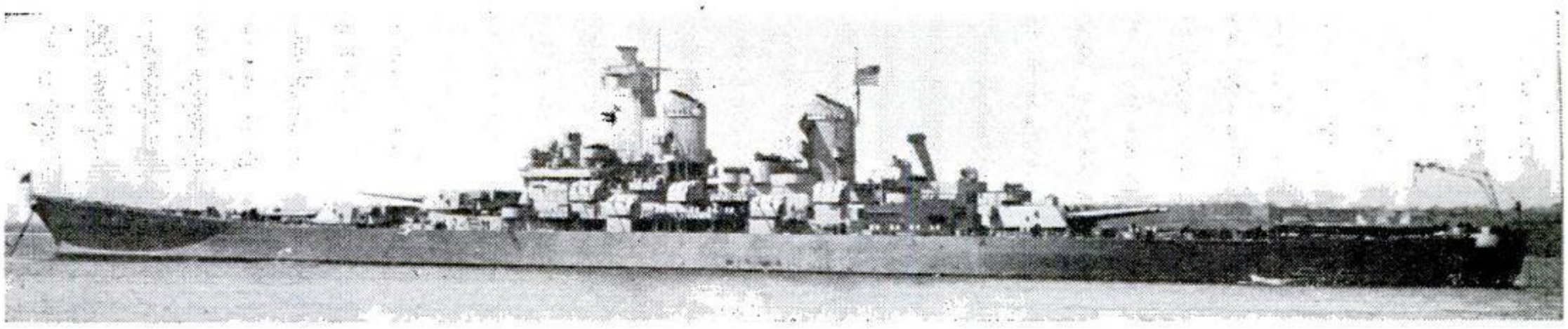
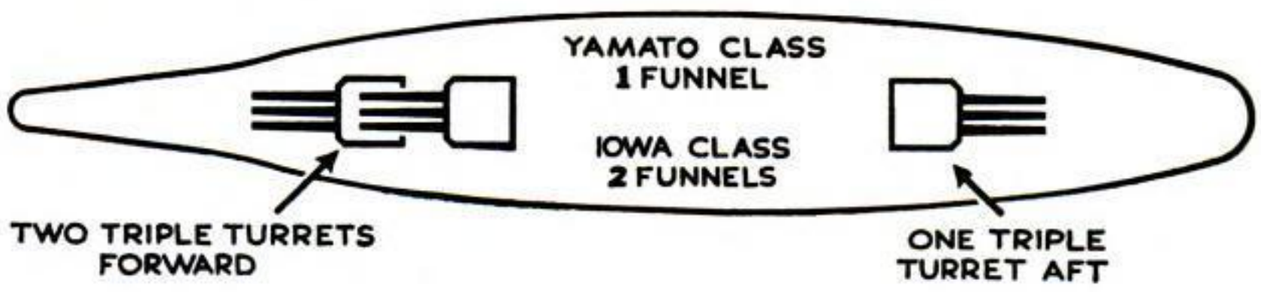
"MYSTERY SHIPS" MAKE FIRST APPEARANCE IN BATTLE



SECRET SUPERDREADNOUGHT. Pride of the Japanese navy, the 45,000-ton Yamato runs for its life under a terrific pounding by aerial bombs. We knew the Japs were building mammoth battleships like this, and the Philippines battle brought them out of hiding. Inset: silhouette of the Yamato class

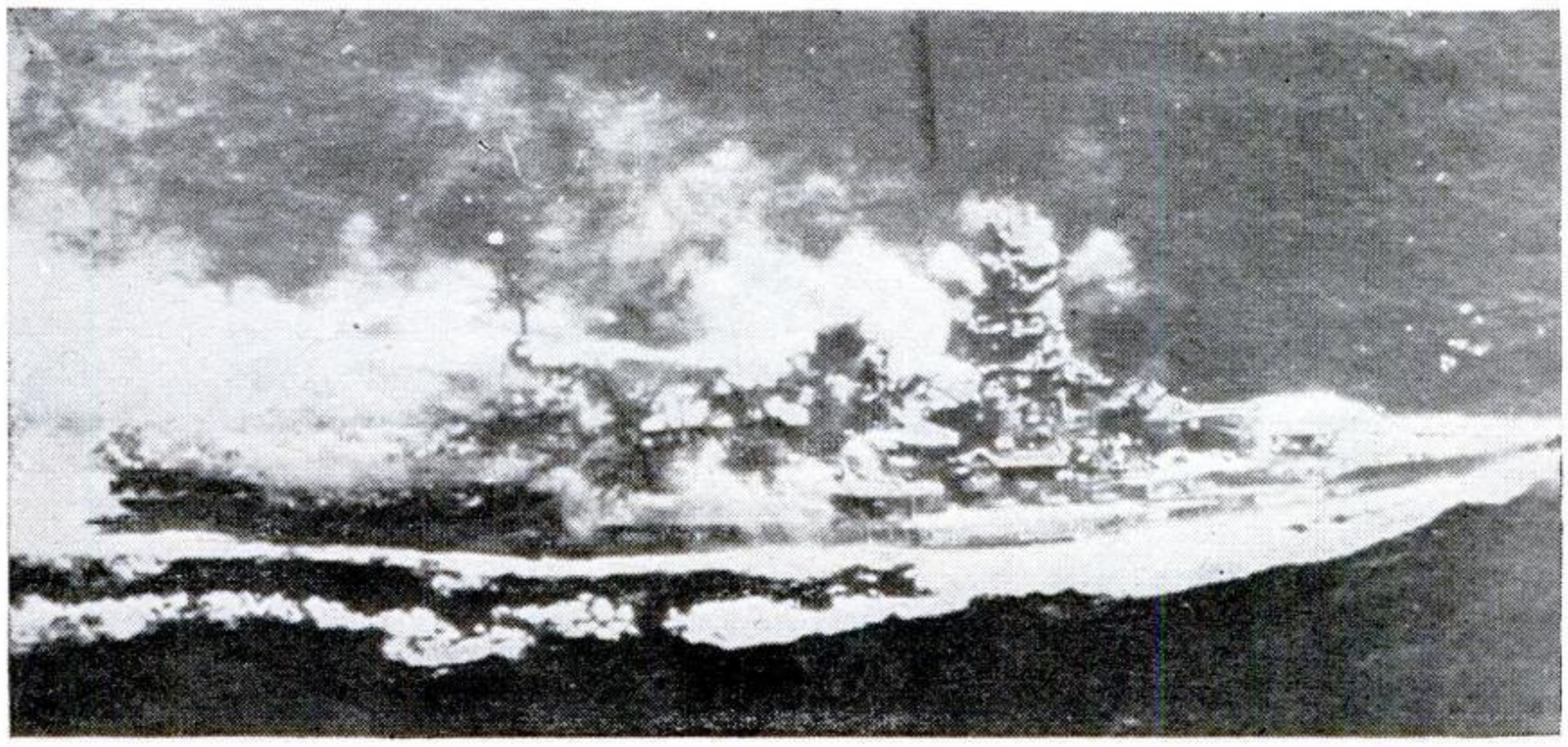


YAMATO vs. IOWA. Comparison reveals both similarities and differences. Our Iowa (above) has two funnels to Yamato's one, but general hull design and placing of big guns is the same, as shown at right (drawing not to scale)



wagons. As in standard American practice, two turrets have been placed forward and one aft—the latter all but obscured in the picture by smoke and wreckage. Since the battle, Fleet Admiral Chester W. Nimitz has announced that the *Musashi,* sister ship of the *Yamato,* is now definitely known to have blown up and sunk as the result of damage inflicted on her by U. S. carrier planes in the same engagement.

Battleship-carriers, strangest of naval hybrids, have appeared in the converted Jap battleships *Ise* and *Hyuga.* The freak ships appear to combine the worst features of



HYBRID. Battleship and carrier in one, this freakish Jap man-of-war sacrificed two turrets to make room for a tiny "flight deck" aft. She is fleeing after bomb and torpedo hits by planes from U. S. carriers

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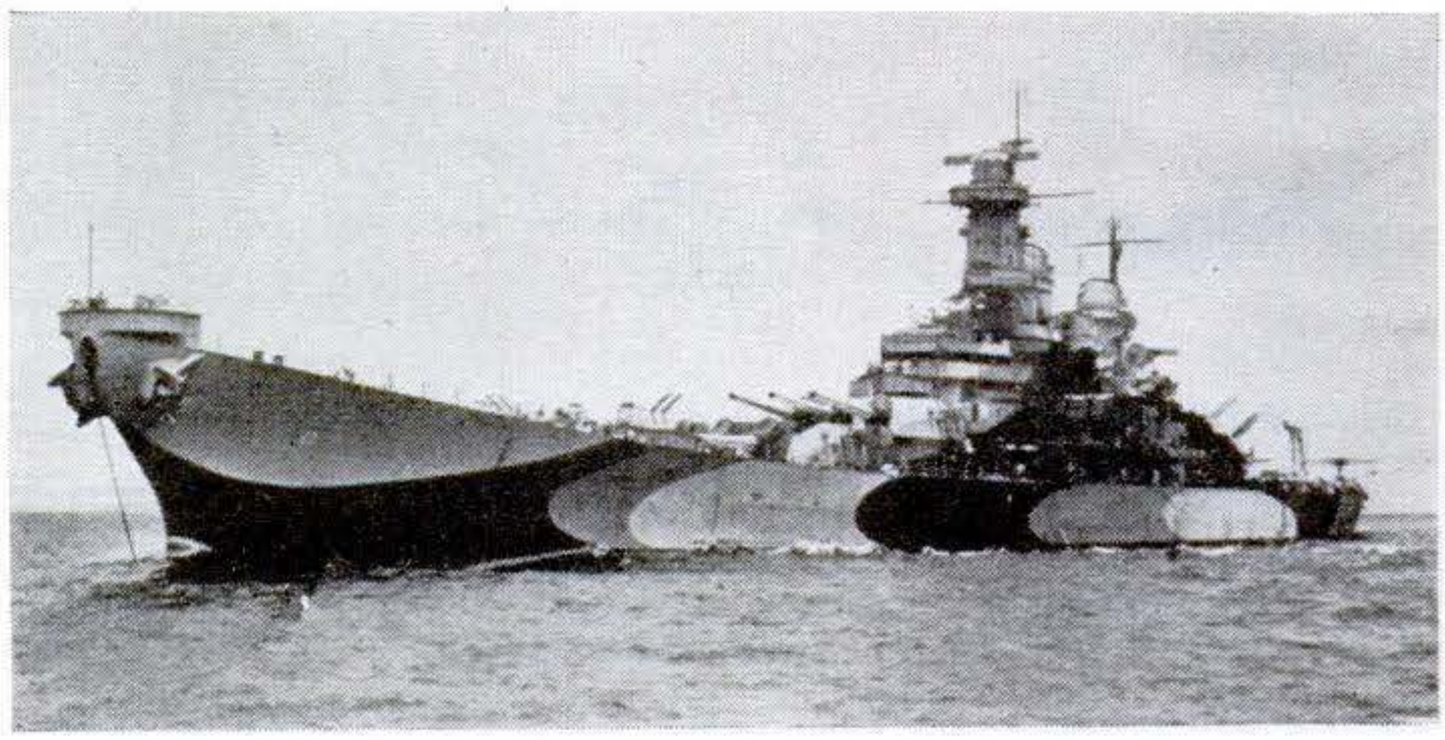
both types. Each provides a "flight deck" aft, a fraction of the length of the smallest flattop and apparently suited only to catapult launchings. For the dubious advantage of the "carrier" feature, the two after turrets of each vessel evidently have been removed—a surprising sacrifice of firepower, which Japan can ill afford in her remaining capital ships.

From what we now know of Japan's tools of seapower, the opposing lineups for the Battle of Japan can now be estimated within reasonable limits. At most, Japan can probably muster no more than 11 battleships to our 23—a proportion of more than two to one in our favor. If the Land of the Rising Sun has another *Yamato* class battleship, as naval circles here believe, two of its capital ships are modern, compared with 10 of ours. These figures do not include our newly completed 27,000-ton *Alaska* and *Guam,* which the U. S. Navy calls "large cruisers"—a masterpiece of official understatement.

In other categories of fighting ships — carriers, cruisers, destroyers, submarines—the story again is one of overwhelming American superiority both in numbers and in types. Due for completion in 1945, the mammoth U. S. carriers *Coral Sea* and *Midway,* will match the 45,000-ton displacement of our mightiest battleships and will provide a take-off run long enough for the heaviest bombers ever launched at sea. They will dwarf even the 33,000-ton *Saratoga,* veteran of our carrier forces, and the 13 or more *Essex*-type carriers of more than 25,000-ton size that we have completed since we entered World War II. Our latest superdestroyers, displacing 2,200 tons, approach small cruisers in size and armament. And now transports and cargo landing craft, which formerly brought troops and supplies to beachheads already secured, are giving way to "assault ships" that take direct part in amphibious fighting operations. Comparatively shallow draft enables them to launch

SUPERDESTROYER. Resembling a small cruiser, the 2,200-ton Allen M. Sumner typifies the growing size of U. S. ships of all types. Its tonnage is exactly twice that of the four-stackers that fought the Germans in the First World War



45,000-TON BATTLESHIP. War paint decorates the Missouri, new member of our Iowa class. "Big Mo" and her sister ships are believed to be the only men-of-war in the world that outclass Japan's Yamatos ship for ship. The gun nest on the Missouri's bow distinguishes her from the Iowa (page 91)

GHOST SHIP. Heavily damaged at Pearl Harbor, the refitted California returned to the battle line and settled an old score with blazing guns off the Philippines. Doubtless, the Japs wish their bombers had done a better job. Four other battleships damaged in the sneak attack—Pennsylvania, Maryland, Tennessee, and West Virginia—also have avenged themselves

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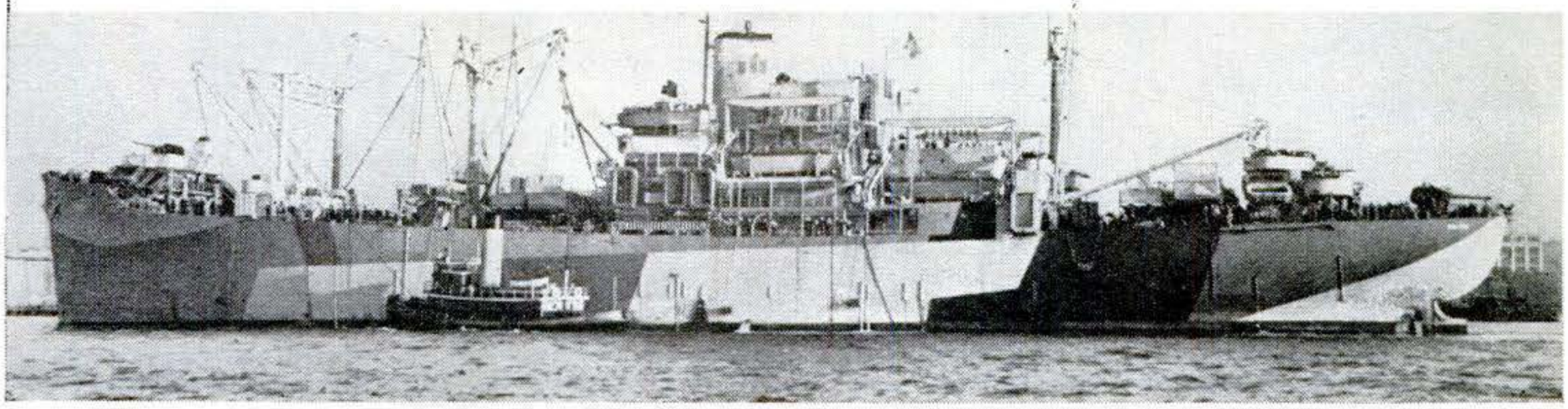
ARE CARRYING THE BALL FOR THE U.S. IN THE PACIFIC



ASSAULT SHIPS. Heavily armed transports, developed for use in Pacific invasions, take a direct part in amphibious operations and cover troops as they dig in. Above is the 492-foot U.S.S. Burleigh, an "APA" in Navy parlance. Successful experiments have also established converted destroyers, called APD's (right), as standard ships for fast transport of smaller contingents

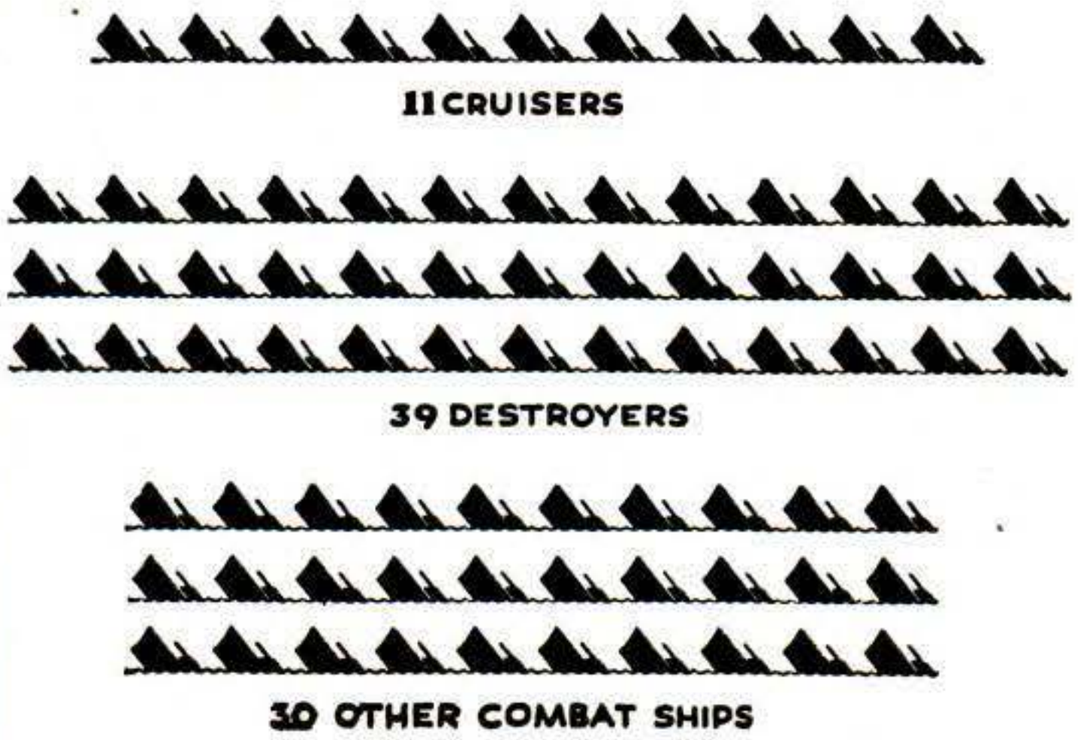
invasion barges and cargo lighters close to shore, and heavy armament covers landing parties while they dig in. Top priority has been given to mass production of these assault ships, designed especially for use against Japan.

Assault transports, or APA's for short, land a complete combat team of hundreds of men. Simultaneously, assault cargo ships, or AKA's, bring up ammunition and miscellaneous supplies. Plans for a given operation call for a definite ratio of AKA's to APA's. Larger than standard Atlantic landing craft, the assault transports provide commodious quarters and anti-tropical ventilation, so that the men will arrive fresh and full of fight after a voyage lasting for weeks instead of days.

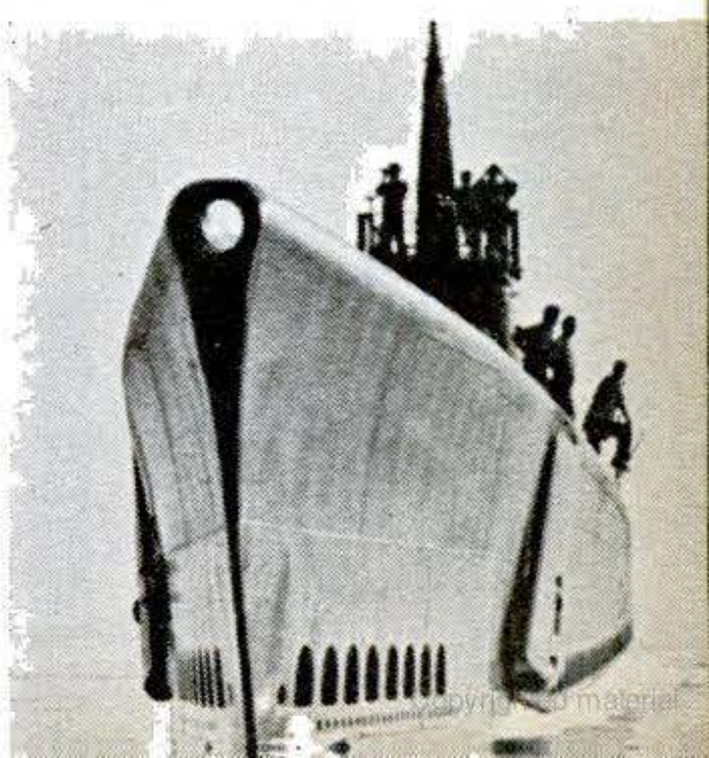
Converting destroyers for use as fast troop transports provides another way of landing invasion forces. First tried out some years ago, the experiment has proved so

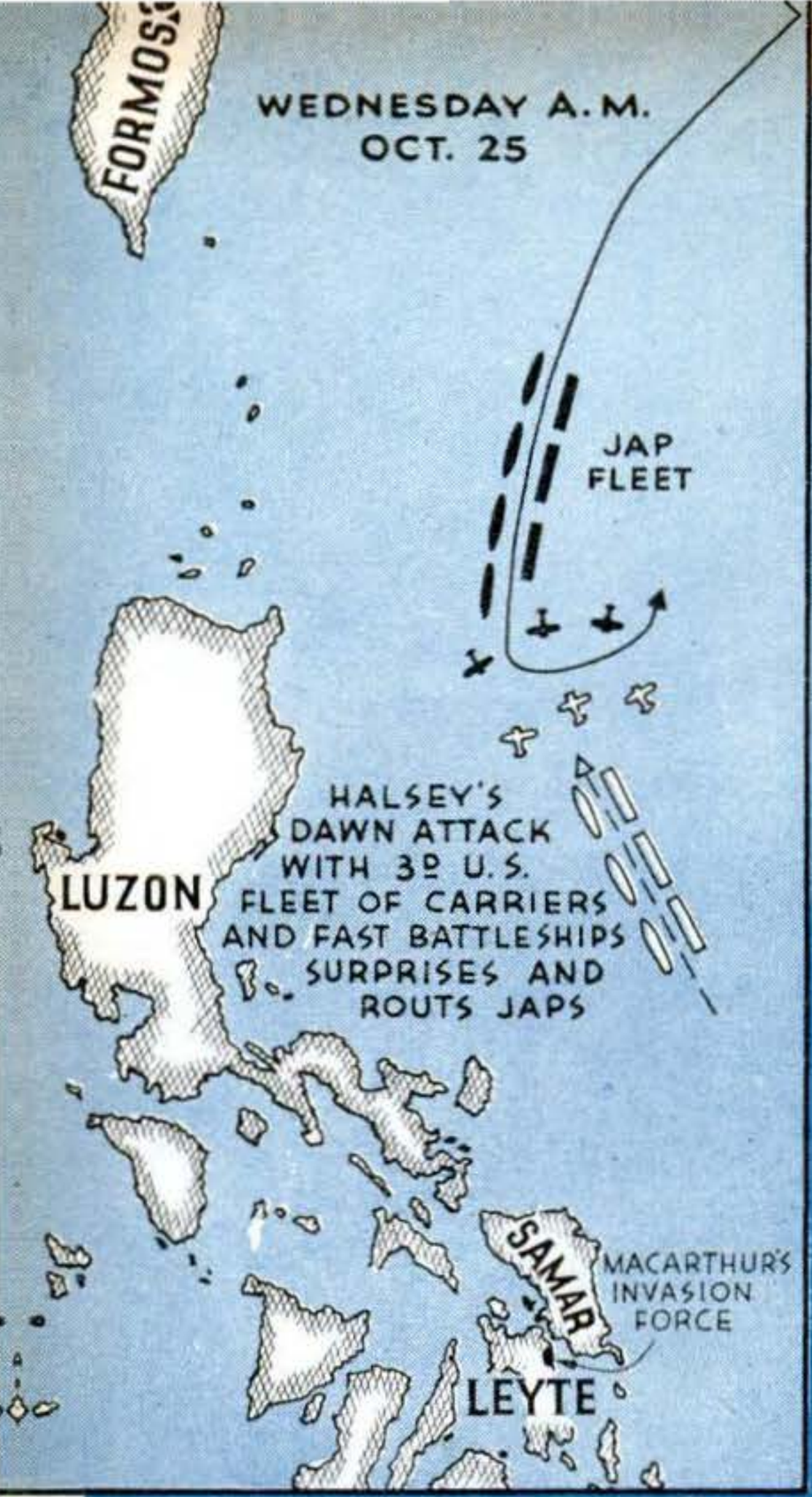
OUR SUBS HAVE TAKEN A HEAVY TOLL OF ENEMY SHIPS

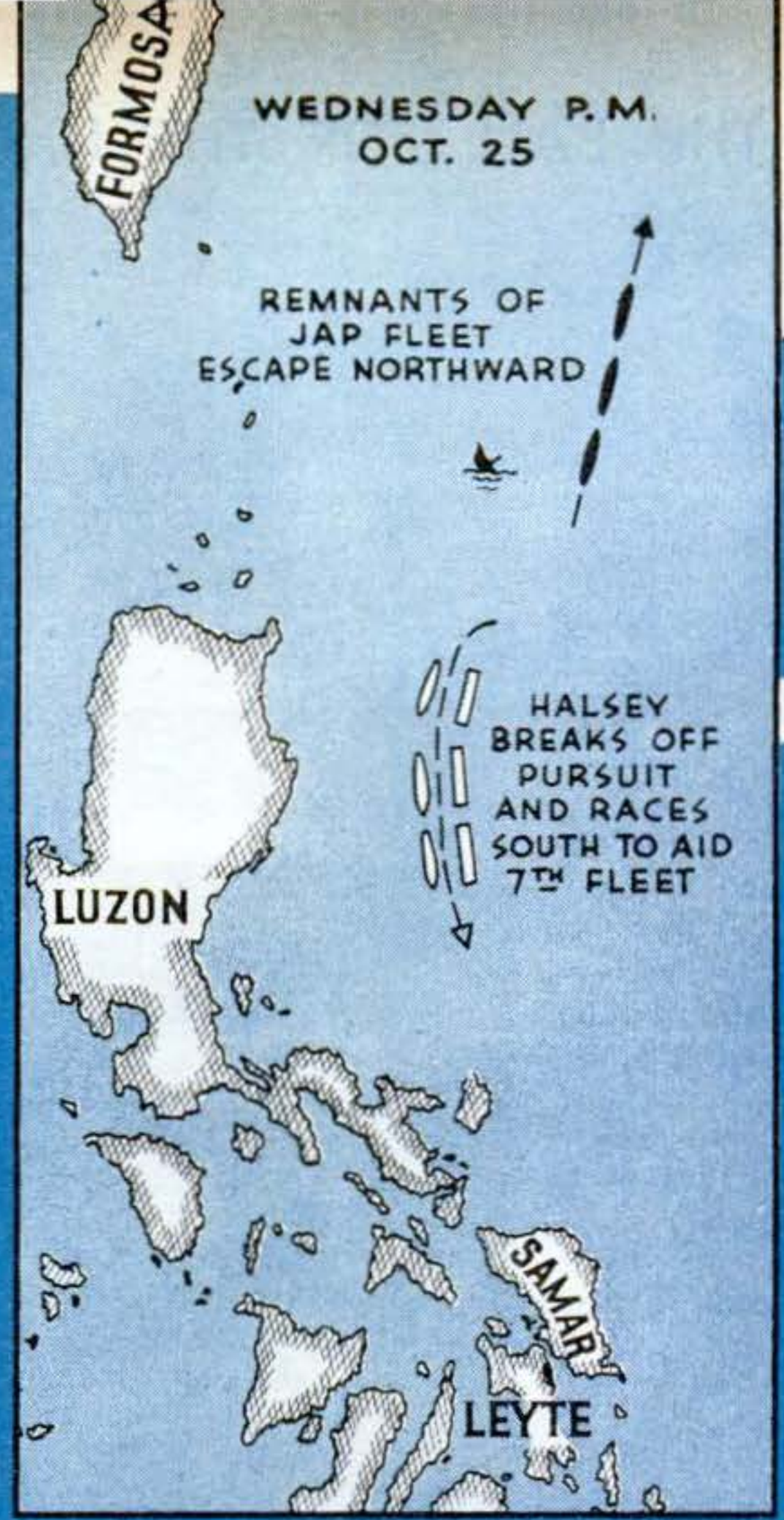
Penetrating the home waters of Japan, daring U. S. submarine commanders and crews have hacked at the enemy's irreplaceable naval and cargo tonnage. The scores given below show ships definitely sunk in the first three years of the war. "Probables" and damaged craft would boost the tally far higher than this



A U. S. sub returns from a raid. The umbrella-like object is a covered deck gun







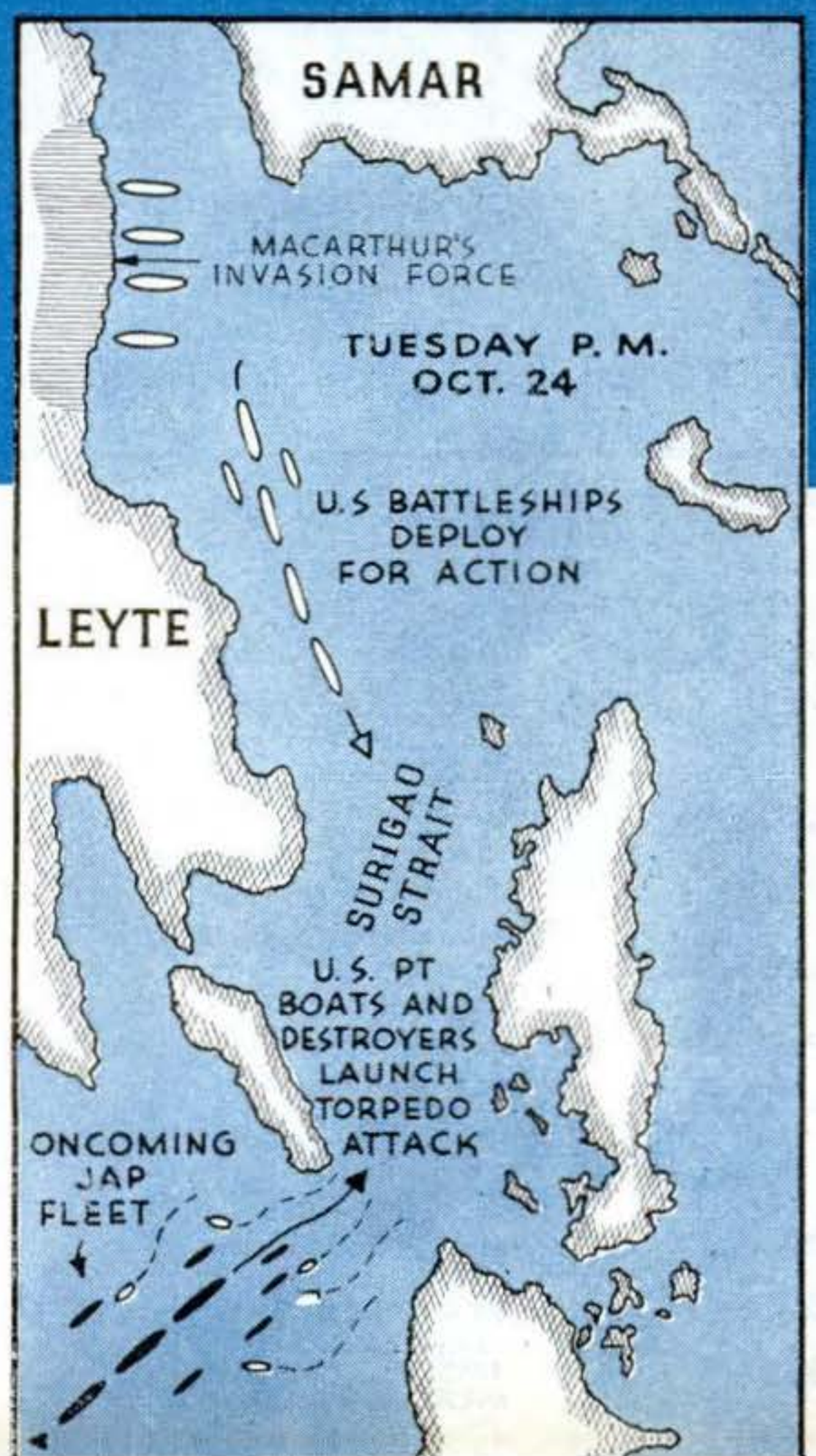
NORTHERN ENGAGEMENT

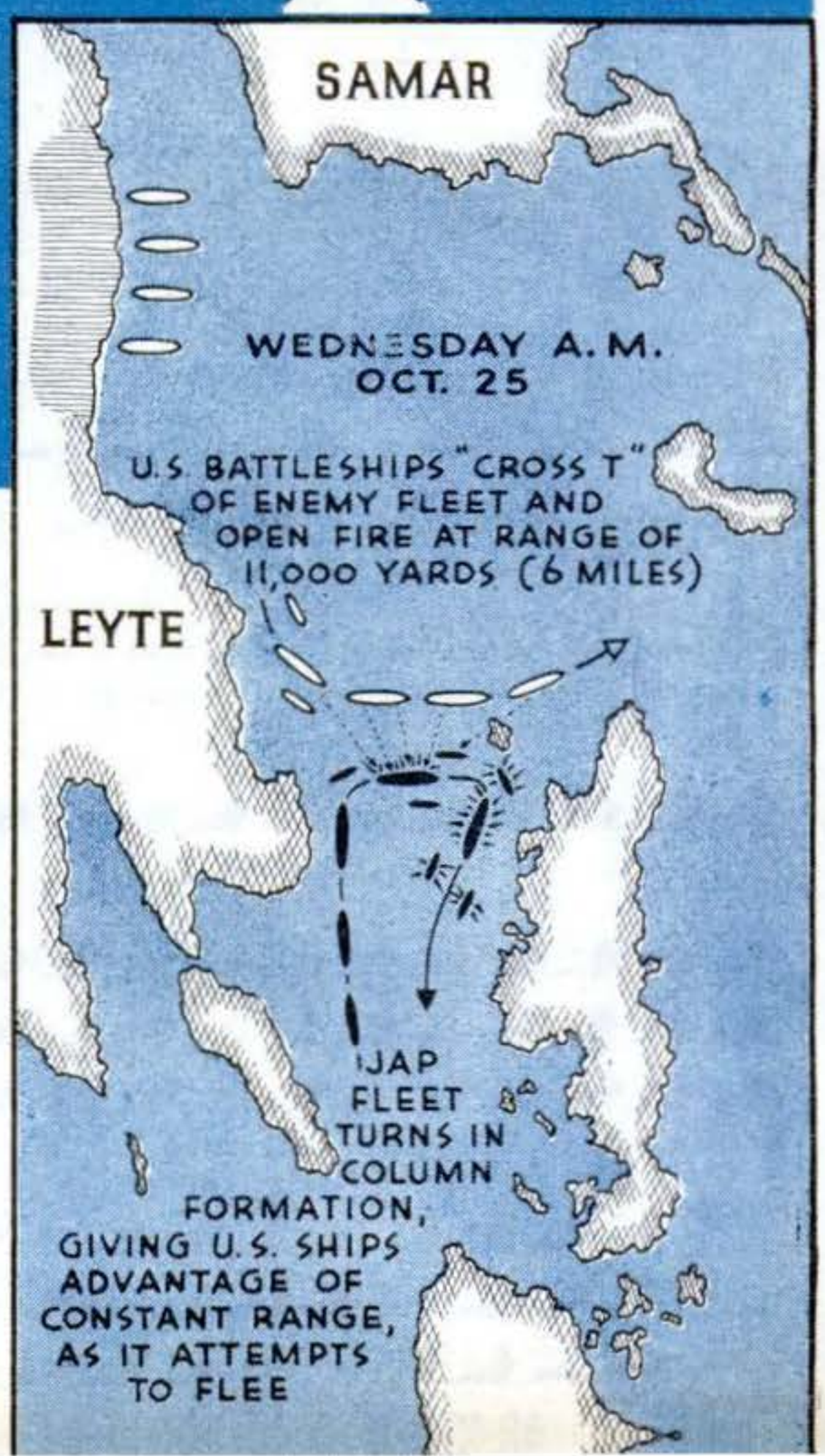
The map at left, above, shows the beginning of Admiral Halsey's "double play." Warned by a scout plane of the approach of a Jap fleet from the north, he speeds northward in the night to contact the enemy in a surprise dawn attack that sinks the hostile carriers while other battered ships flee. Right, U. S. force turns back to meet the central Jap fleet

SOUTHERN ENGAGEMENT

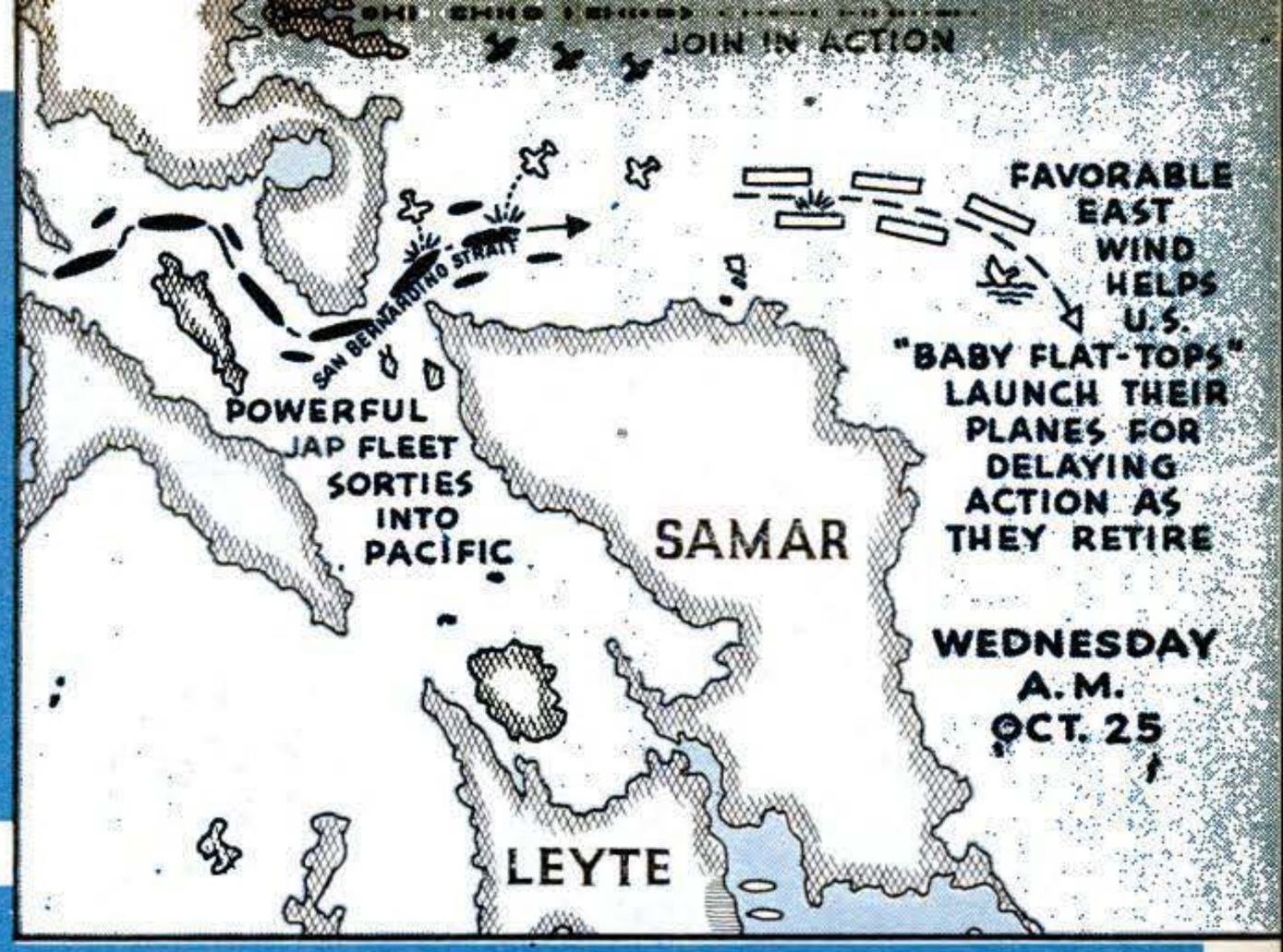
Steaming to meet a Jap fleet entering Surigao Strait (first map), Admiral Kinkaid smashed it with a classic naval maneuver (middle map). Pursuit (map at extreme right) revealed that a destroyer or two were all that escaped out of the entire enemy fleet

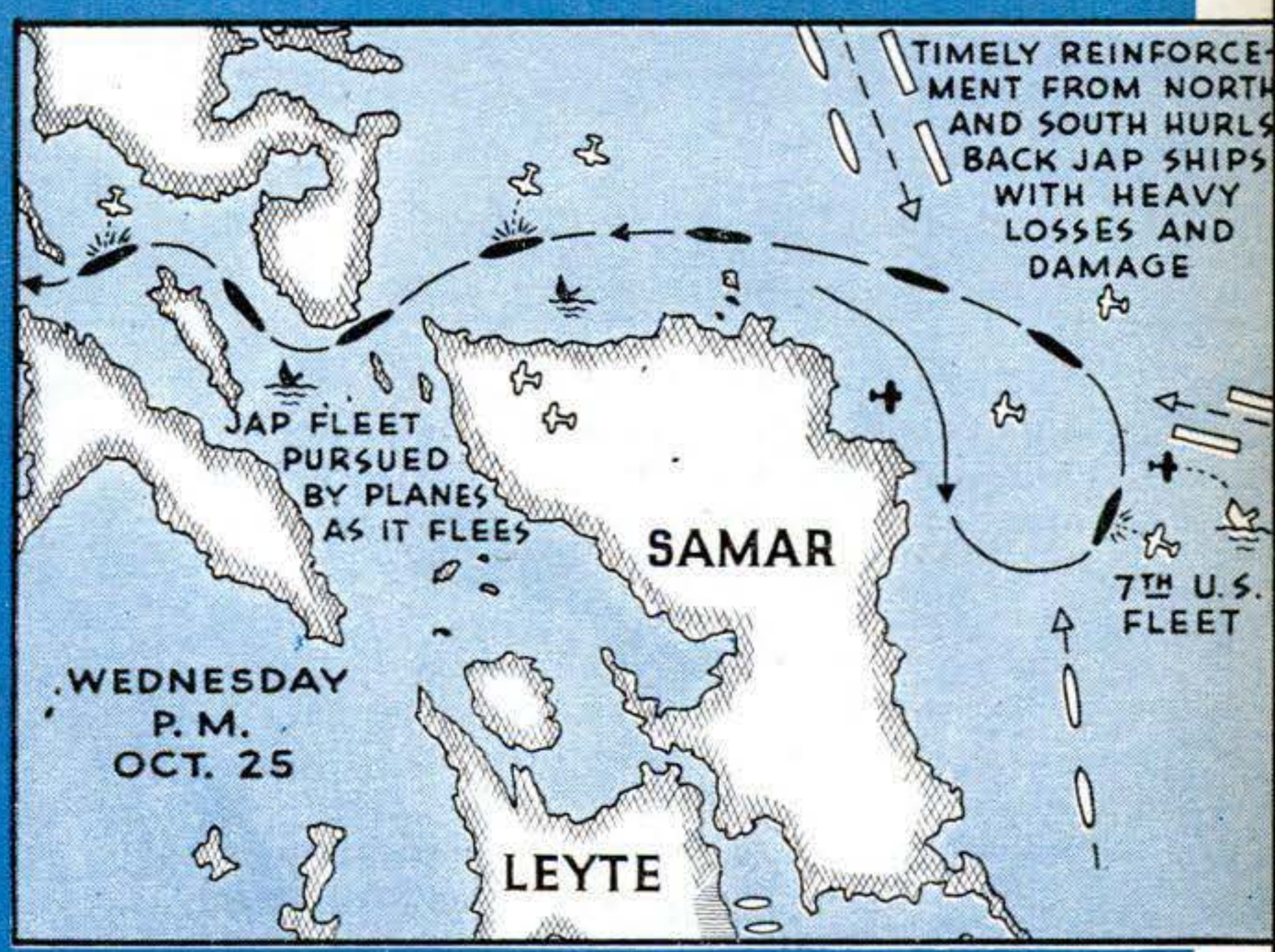
Maps by Sigman-Ward

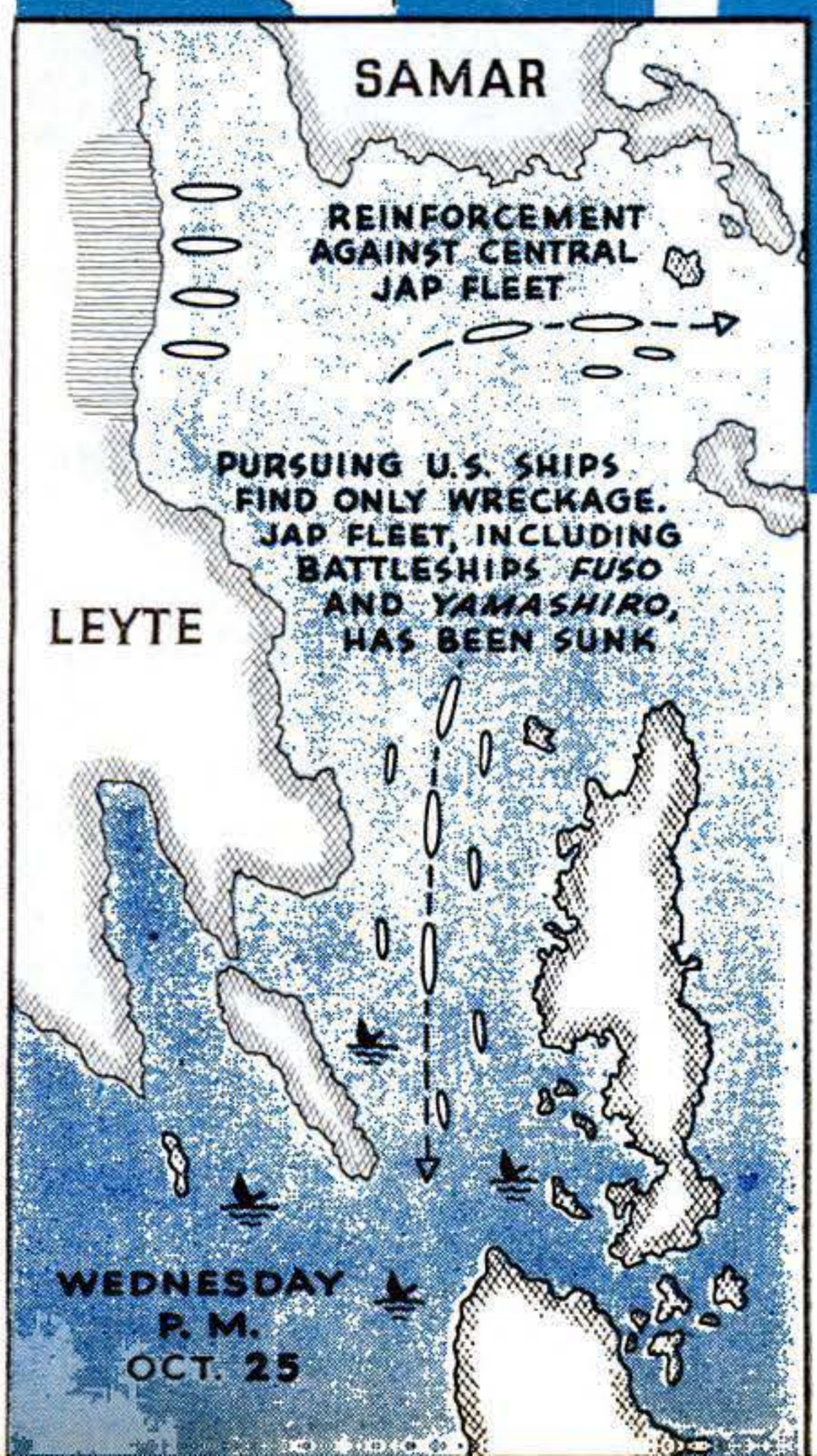




This is the scene of the great Philippines naval battle — an area extending over thousands of square miles — where hard-hitting U. S. warships and planes smashed the bulk of the Japanese Navy. Highlights of the three-in-one clash are shown in detailed drawings, simplified to emphasize the principal features. Broad arrows show where these views fit into the over-all picture







CENTRAL ENGAGEMENT

In the upper map, an overwhelming enemy fleet coming through San Bernardino Strait pushes back light U. S. vessels to force its way into the Pacific, turning south to close pincers on MacArthur's Leyte beachhead. Threatened by the converging Seventh and Third U. S. fleets freed by victories to north and south (lower map), Japs flee under heavy pounding by planes

successful that the APD's, as they are called, have become standard ships of the U. S. Navy.

"Beach rockets" of 4½-inch size, which blast shore defenses with the punch of 105-mm. artillery shells, now are fired in salvos by specialized landing craft carrying hundreds of them, according to a recent statement by Rear Admiral George F. Hussey, Jr., Chief of the Navy Bureau of Ordnance. Owing to the stepped-up tempo of the Pacific war, rocket-firing ships and planes will require a threefold increase over the nearly $100,000,000-a-month production of the projectiles a few months ago, the Navy estimates. Besides explosive rockets, the Navy employs

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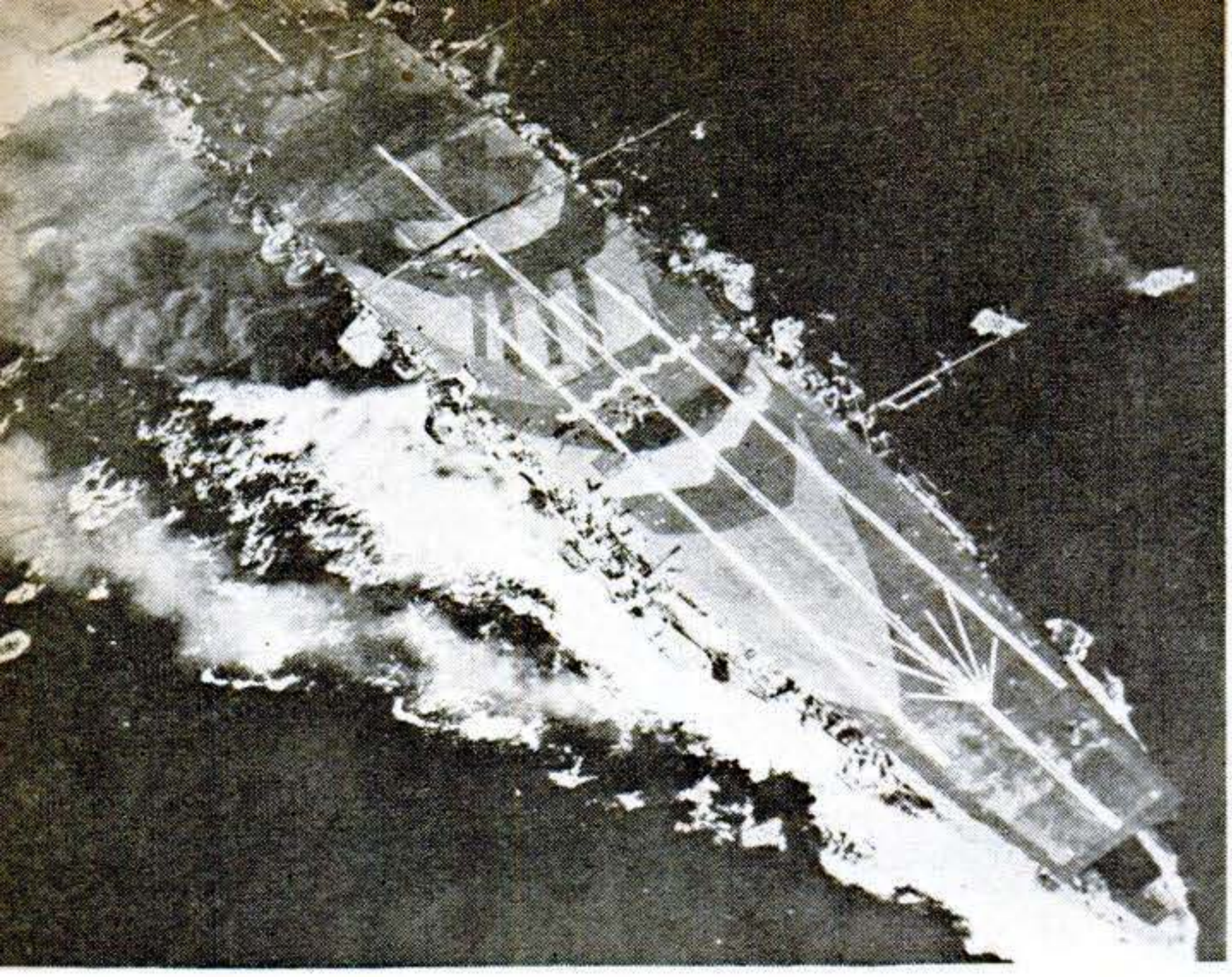

CAMOUFLAGED CARRIER. Painted with imitation turrets, guns, and superstructure, this Nip flat-top was meant to be taken for a battleship. Not fooled by the disguise, U. S. bombers pounced upon the two-timing craft and sank it, in spite of the desperate zigzagging that is apparent in the photograph at the left

LAY OF THE LAND on objectives in the Pacific is studied by airmen and invasion troops with the aid of flexible relief maps of rubber composition. Prepared from aerial reconnaissance photos, the durable three-dimensional charts may be tossed on a deck like rugs and scanned by large groups of men at the same time

incendiary rockets for obtaining range, and smoke rockets for screening troops.

This should be bad enough news for Japan's naval commander in chief, Admiral Mineichi Koga—if he has managed to survive the rapid turnover of Nippon's war leaders—but worse is yet to come. A powerful new British fleet under Admiral Sir Bruce A. Fraser, including ultramodern battleships and carriers, will fulfill Prime Minister Churchill's promise of seapower to help America crush Japan. Not to be confused with the British force in the Indian Ocean, the Pacific armada will be based on Australia, and is expected to operate in close teamwork with Fleet Admiral Chester W. Nimitz and with General of the Army Douglas MacArthur.

These, then, are the tools of Japanese and Allied seapower—so far, a one-sided picture. How about the men who use them? Best-informed opinion ranks Jap naval officers and men as the cream of the Empire's armed forces, whose fanatical courage makes overconfidence on our part supreme folly. Even with their depleted battle fleet, they may confidently be expected to pounce upon any advantage that our extended lines and the slightest miscalculation may give them. Thoroughly schooled in the unwritten "rule book" of naval warfare, they perform at their best so long as everything goes according to plan—as in their sneak attack on Hawaii.

But they have their weaknesses, too. Let plans go awry, and the Jap totally lacks Yankee initiative to grasp and exploit an unexpected situation. And incompetence in his high command, elevated to exalted posts by the feudal system of caste rather than for merit, has had an unfortunate way of placing him in just such embarrassing positions. For six months, the Japs delayed pressing home their temporary advantage at Pearl Harbor—and then dispatched a fleet of warships and troop transports to seize Hawaii. *(Continued on page 228)*

Your Pin Up— NORTH AMERICAN P-51 MUSTANG

Versatility is the word for the fighter featured in this month's pin-up from an official Army Kodachrome. Designed from combat experience, the Mustang started out as a hedge-hopper and worked its way up to high-altitude fighting. As a photo-reconnaissance plane (F-6), it carries guns and bombs as well as a camera

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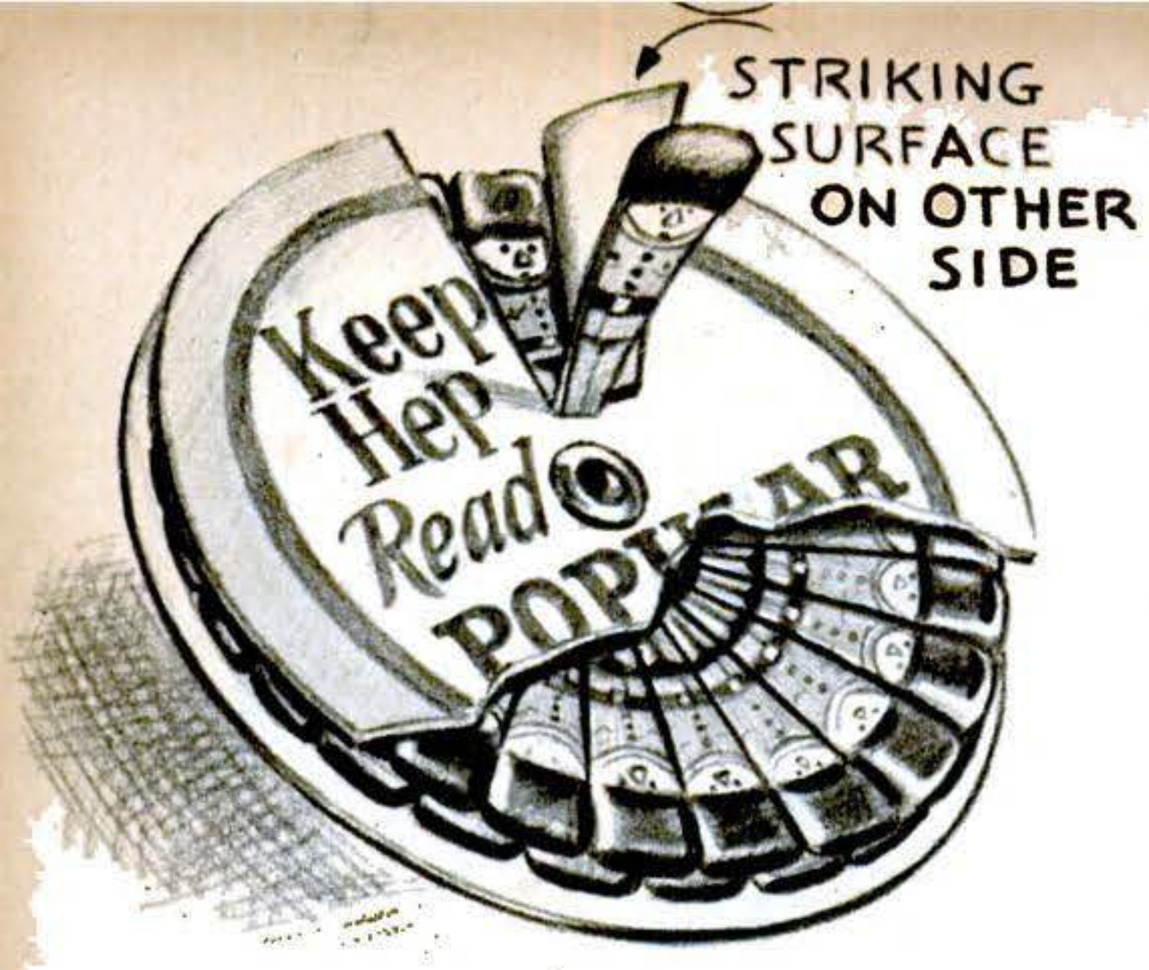
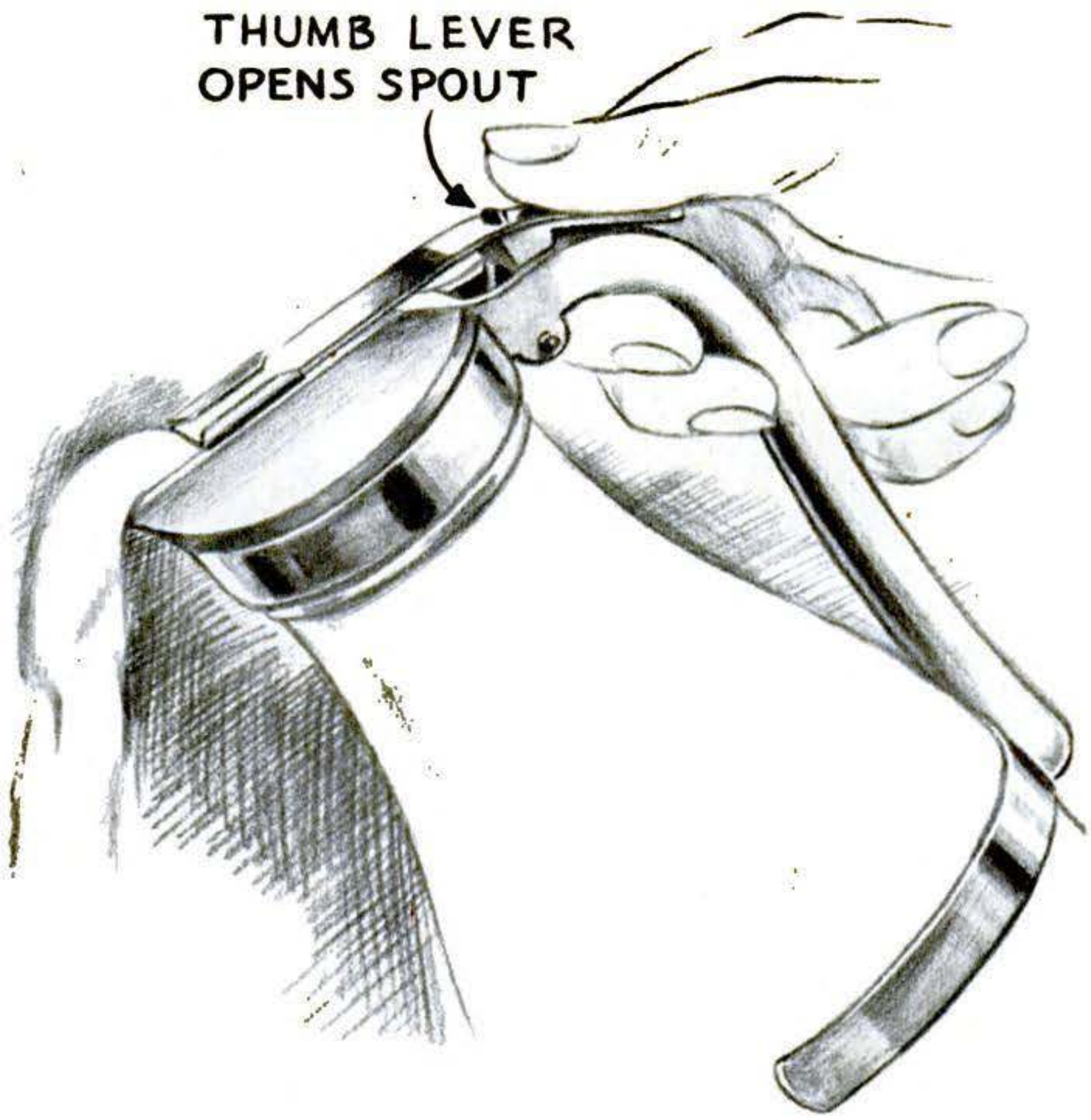


HARDLY MATCHLESS, but safe and convenient is this new container invented by Nathan Hammer, New York City. It consists of two radially arranged cards of safety matches stapled at the axis between cardboard disks. A sector of the cover, slightly larger than the individual triangular match, opens to allow the removal of a unit. This flap is a safety device, for it must be closed before the match can be lighted, since the striking surface is on the outside. Package and matches are well adapted to advertising use through printed sales messages.

EASY POURING from a milk or cream bottle is accomplished with this spout-and-handle attachment devised by Georgia Darnell, San Diego, Calif. It consists mainly of a pouring cap made of adaptable material and fitted with a sliding closure that can be easily brought to an open position with the thumb of the holding hand. There is a vent in the cap to admit air when the bottle is in pouring position. An appropriate handle extends from the edge of the cap and ends in an adjustable clamp that fits the bottle snugly. The device may be left on in the refrigerator, for it occupies only a minimum of additional space.



TWO STRINGS TO ITS BOW. That's why this ladder won't sag perceptibly in use. Made in the form of a bowstring girder, its sides, in which the rungs are fixed, provide the arc; and the tie rods, or bowstrings, the chord. According to a well-known mechanical principle, when a person climbs the ladder his weight tends to straighten the side pieces and thereby put the tie members in tension. The ladder may be made of any suitable metal, either tubular or angle-section, and the tie members of steel tubing or stranded steel wire. Either an extension or a stepladder is formed by locking two sections together, lengthwise or at an angle, by hooks that engage the rungs. The ladder was originated by Frederick Kidd and Thomas Dargue Kidd, Stockton-on-Tees, England.

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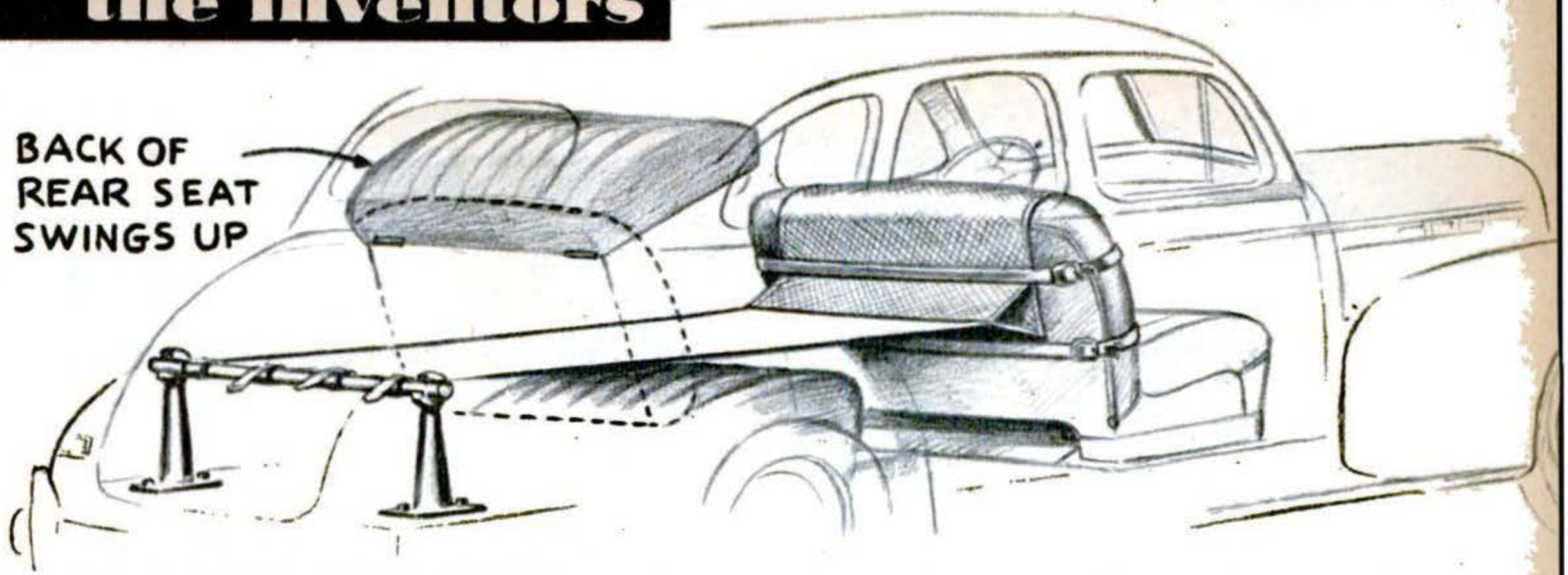
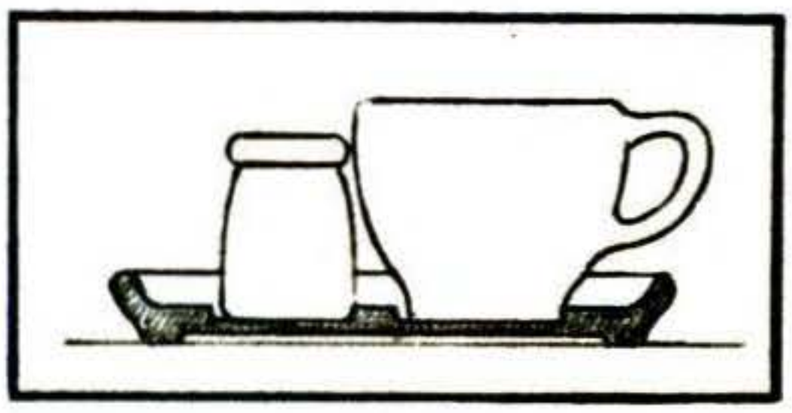
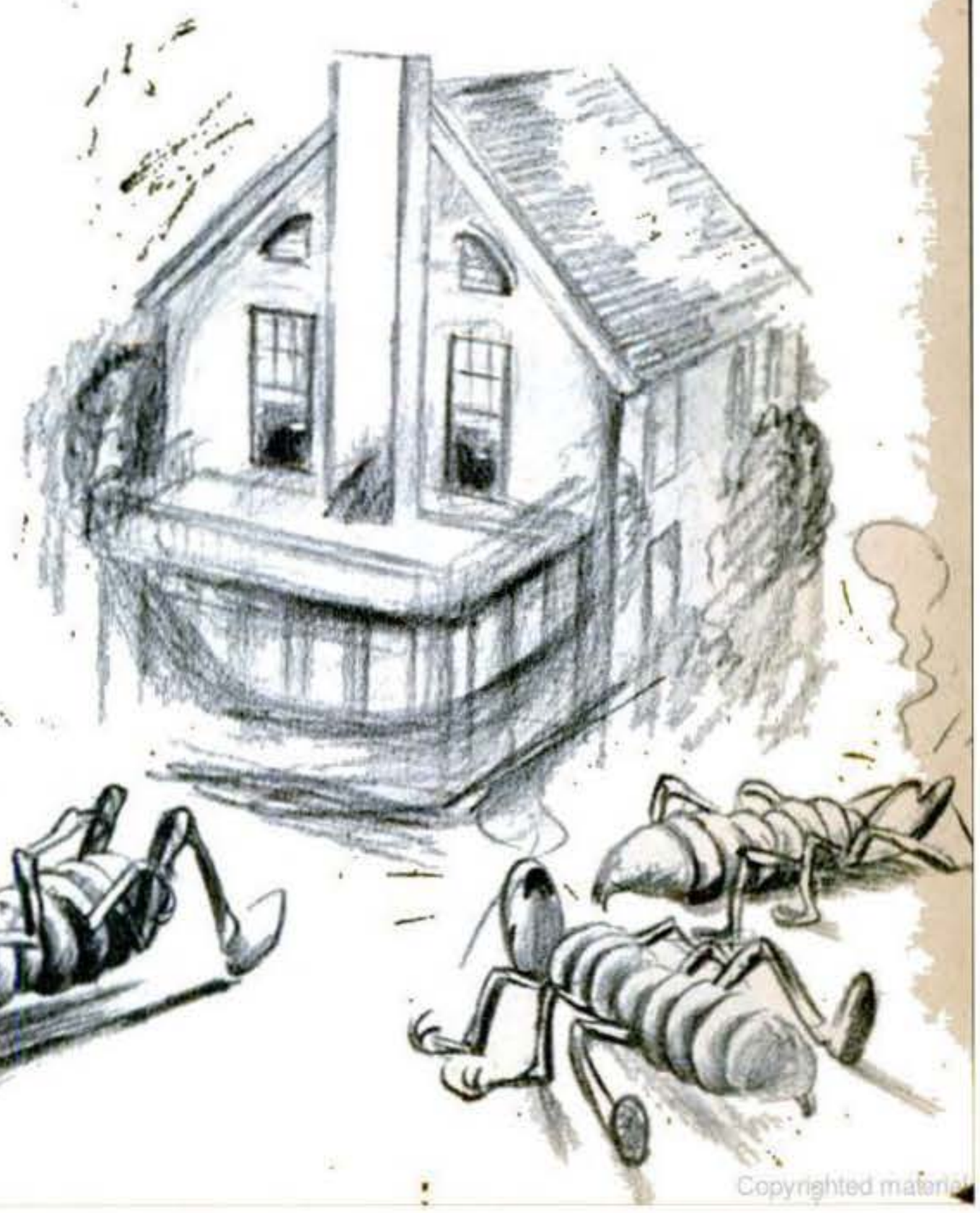


YOUR CAR IS YOUR CASTLE when it is equipped with one of these bedlike hammock arrangements that extend, from an adjustable strap anchorage on the driver's seat, backward under the raised rear seat to a crosspiece bolted to the floor. Not only does the hammock make a comfortable bed for overnight camping trips or when hotel rooms are unavailable, but it is adapted to the transportation of ill or wounded persons. It is the invention of Byron Quinby Jones, of the U. S. Army.



SPILL INSURANCE for coffee is the idea behind the saucer designed by Albert Rasch, Portland, Ore. This new piece of restaurant crockery is provided with two circular recesses, one for the coffee cup and the other for the cream jug.

TERMITES DON'T LIKE dichloro-hexanitrotoluene, a chemical formula worked out by a St. Paul, Minn., man, Frank H. Kaufert, who has assigned his rights to Du Pont. The new substance, which is a complex relative of the explosive TNT, is dissolved in a petroleum vehicle, and the method of protecting wood from termite attack is to impregnate the ground surrounding it with the solution. Other insects and organisms yield to the chemical's action.



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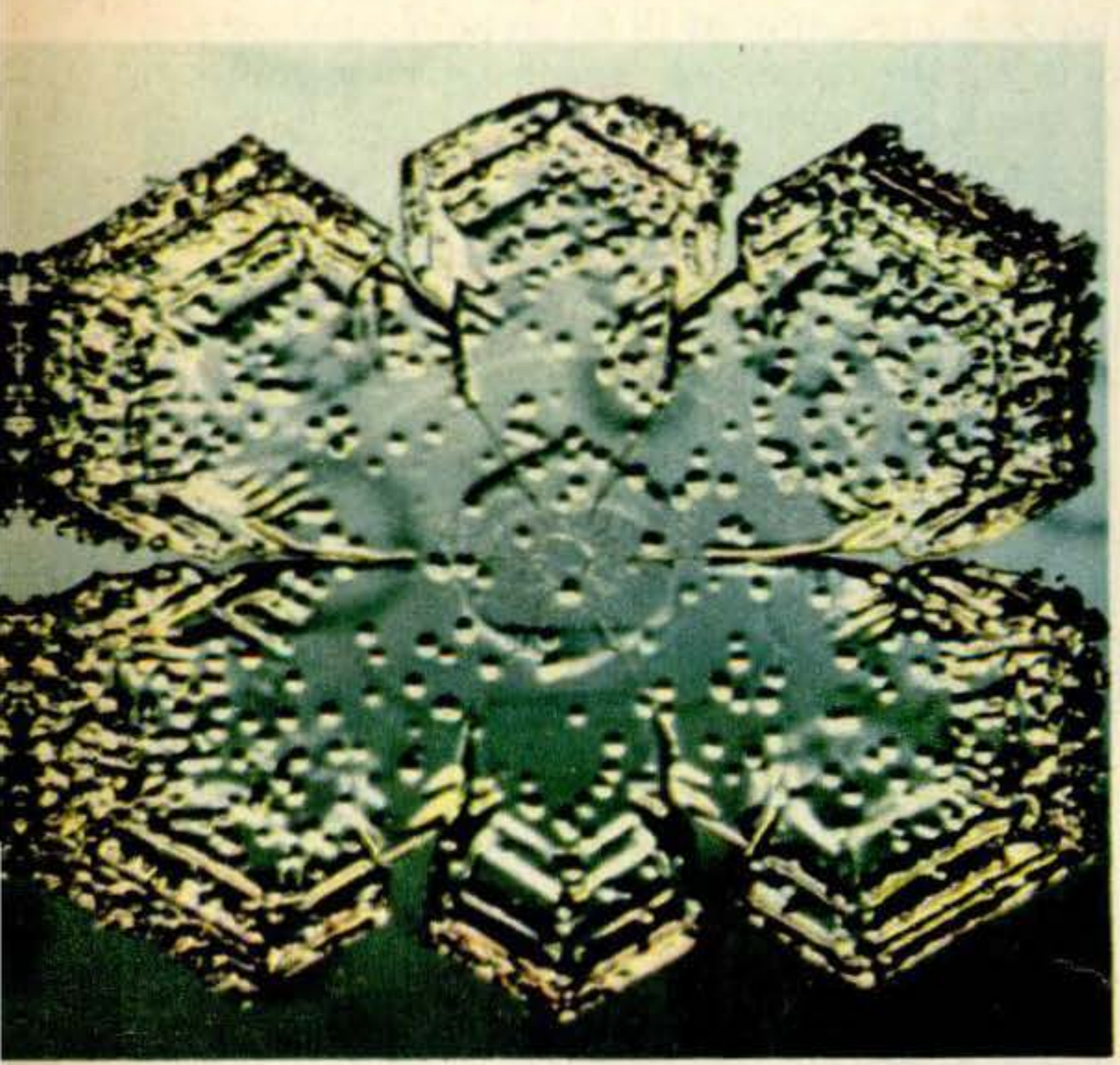
How I Take Stereo Pix in COLOR

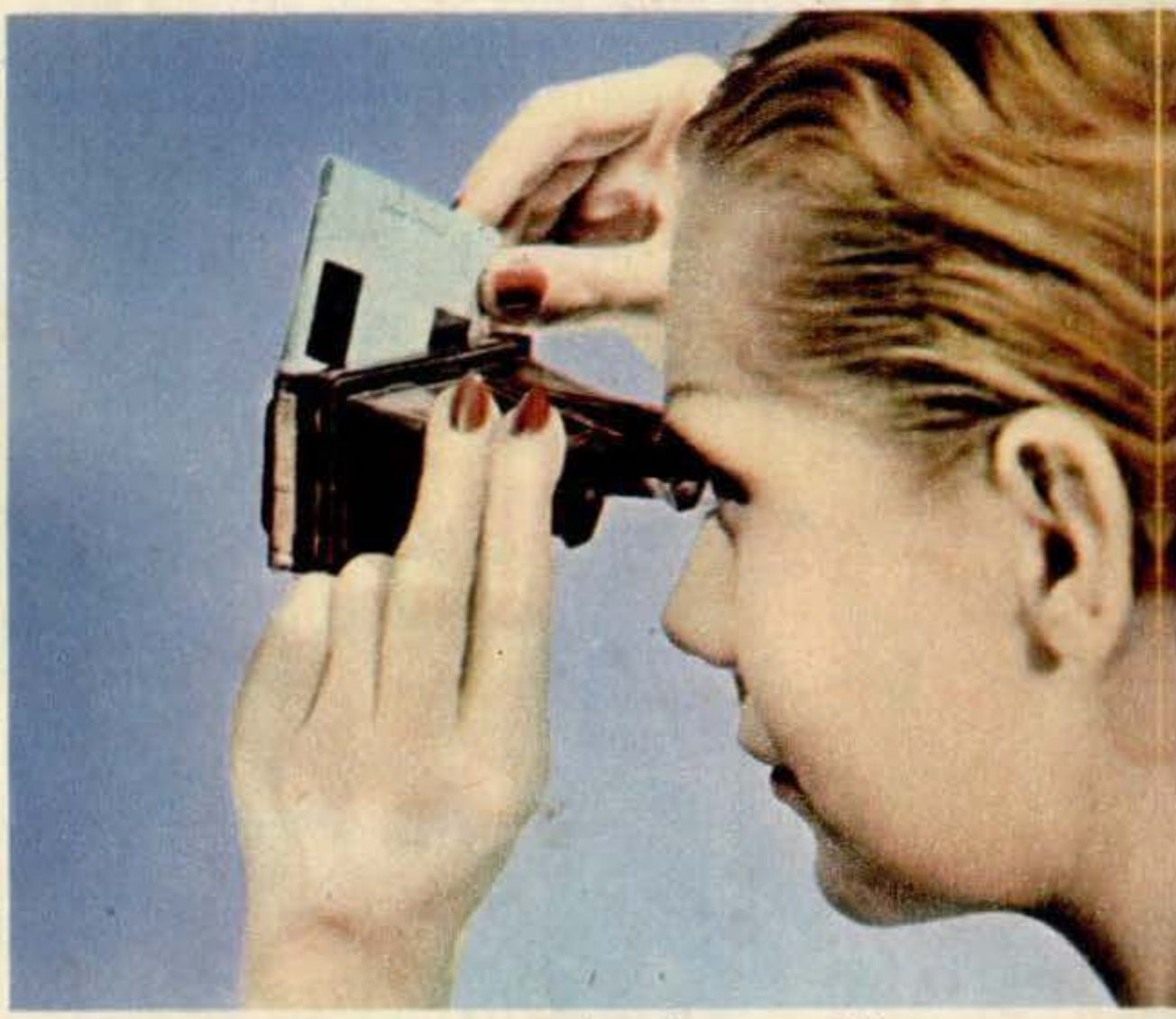
An Interview with Corydon M. Grafton, by Robert E. Martin

TO ONE amateur photographer, a New England snowstorm is more than welcome. It means just one thing to him—a chance to capture another delicate snow crystal and record its fleeting beauty on color film for stereoscopic viewing. Using techniques that are all his own and photographic apparatus he has built with his own hands, Corydon M. Grafton obtains remarkable results.

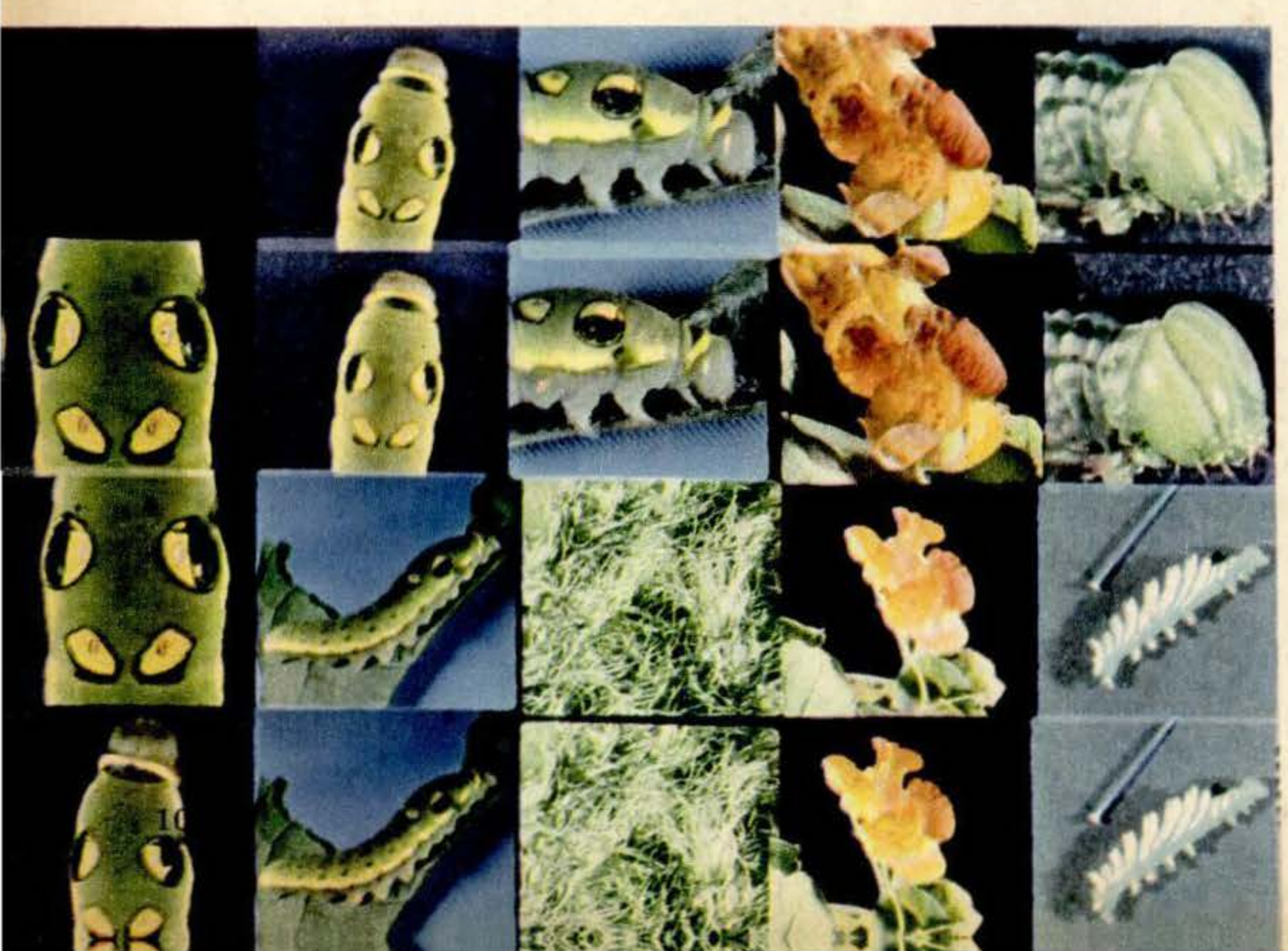
With slight alterations of method, Grafton achieves equally fine results in photographing insects, flowers, and even tiny seeds. Using his homemade bellows, which has a



Tinted cellophane in front of the light source accounts for the colors in this white snow crystal



Crystals "shot" from two angles show modeling when transparencies are viewed in a stereoscope



Grafton makes 20 exposures on one four-by-five film for two reasons; for economy, but equally to obtain increased depth of focus. He achieves this double end by moving his plate holder about on a specially made camera back with guide lines for spacing the exposures

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AMATEUR PHOTOGRAPHER GETS RESULTS WITH ORIGINAL METHODS AND HOMEMADE EQUIPMENT

Much-magnified portrait of a katydid taken by Grafton with his homemade camera

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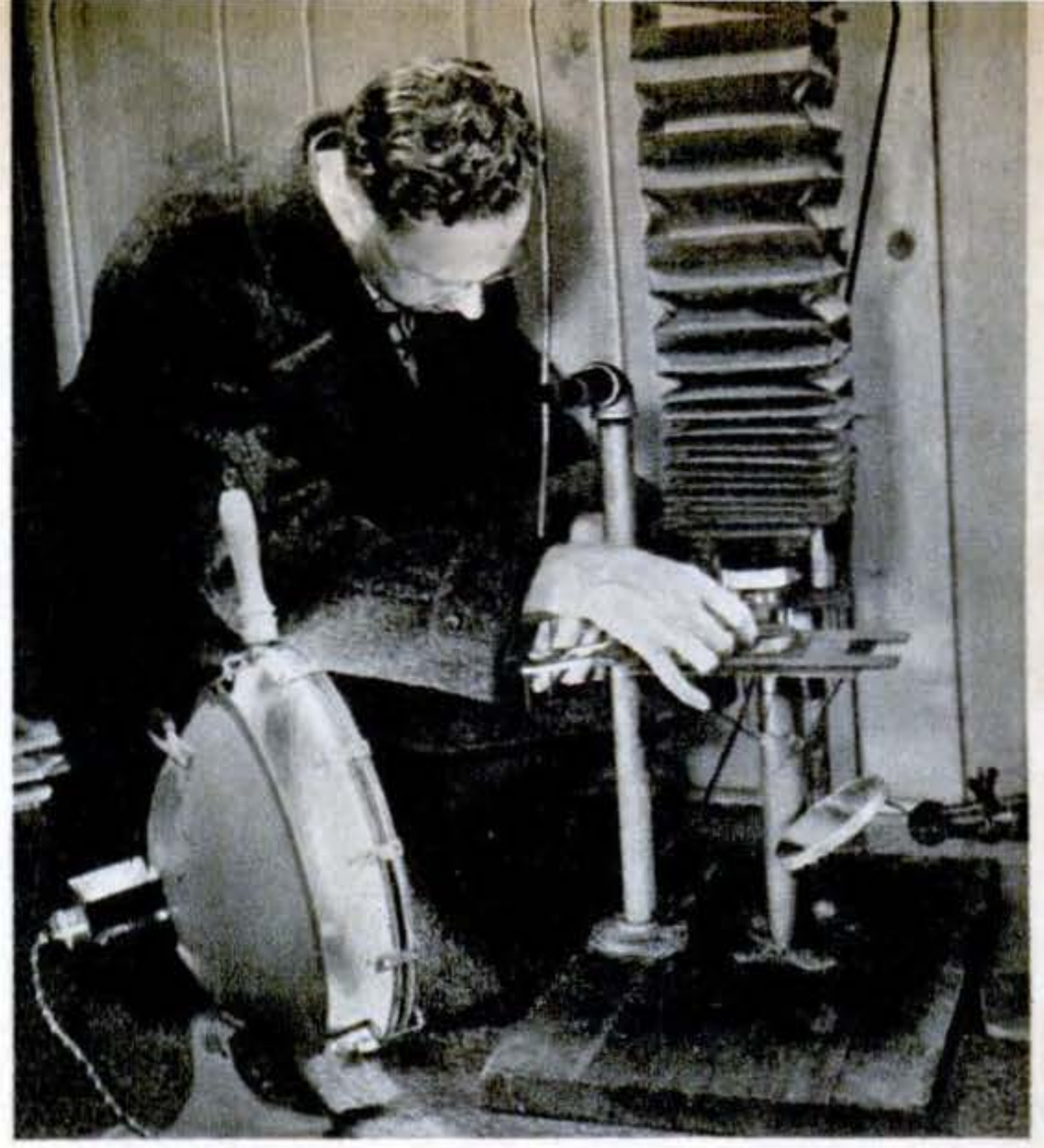
1 Snowflakes are caught on a black cloth. Grafton uses a small paintbrush with clipped bristles to pick off the desired crystal. Studio must be cold



2 Crystal on chilled slide is placed above half-inch hole in a brass block kept cold by solidified carbon dioxide. Thus light can penetrate from below

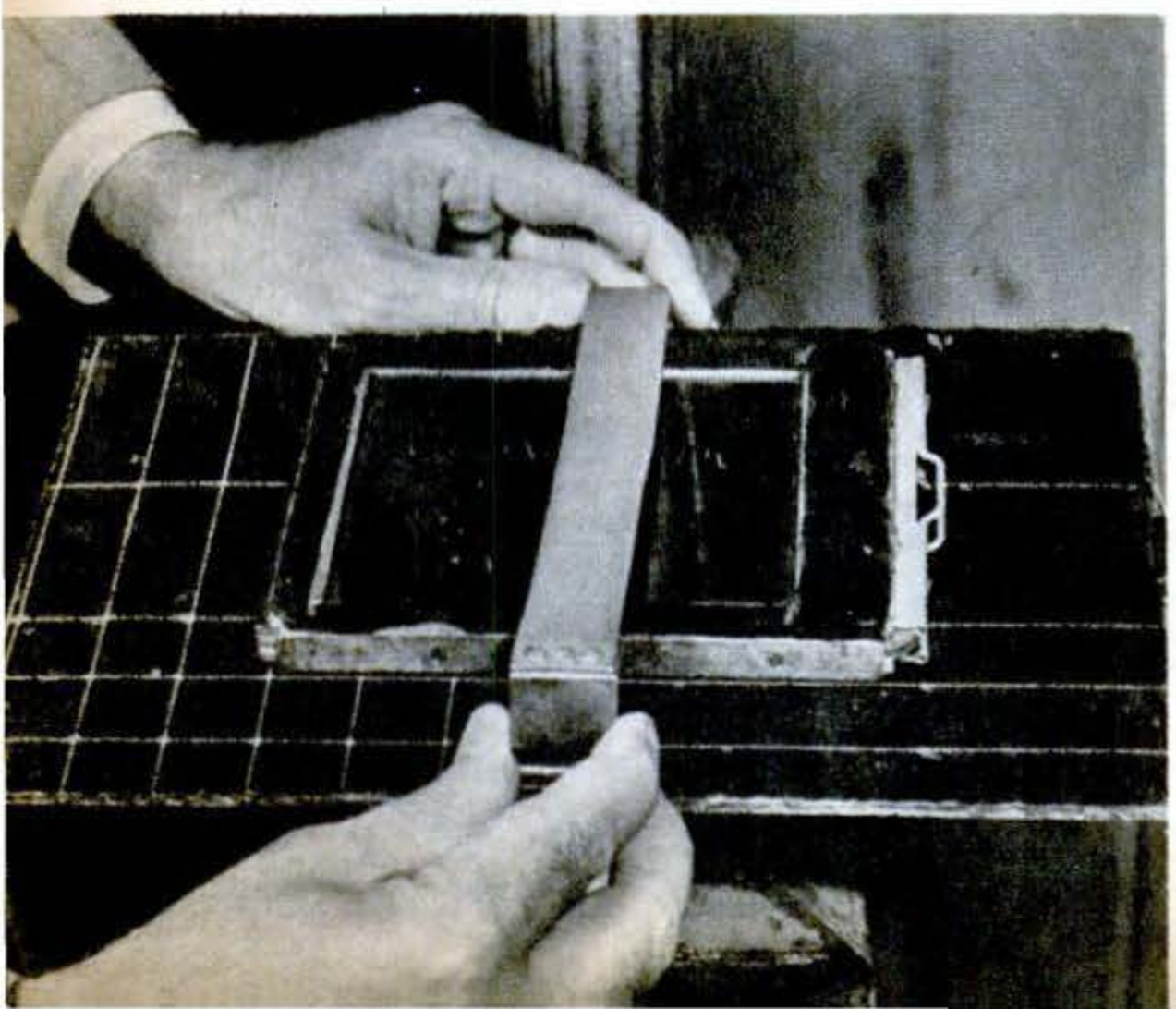
three-foot draw, he magnifies his subjects up to 30 diameters. The pictures reproduced on these pages are samples of his work. Viewed in a stereoscope, they are even more remarkable.

In his two-color shots of snow crystals, Grafton is really "gilding the lily," for these crystals actually are colorless. He gives them tints by using cellophane filters of two colors over his light source. The stage on which he places the crystal is on a horizontal swivel, so that he can tilt it for obtaining two shots at different angles for his pairs of stereo pictures. To retain a snow crystal in its original form requires careful control of temperature. A little too much warmth, and it melts; a little too cold, and it becomes covered with frost. Slightly above the dew point is the right temperature, Grafton has found. He works in a cold studio and has a special stage for the snow-crystal subject, a brass plate about a half inch thick, which is kept cold by means of a piece of dry ice. The microscope slide on which he places the crystal also is chilled.

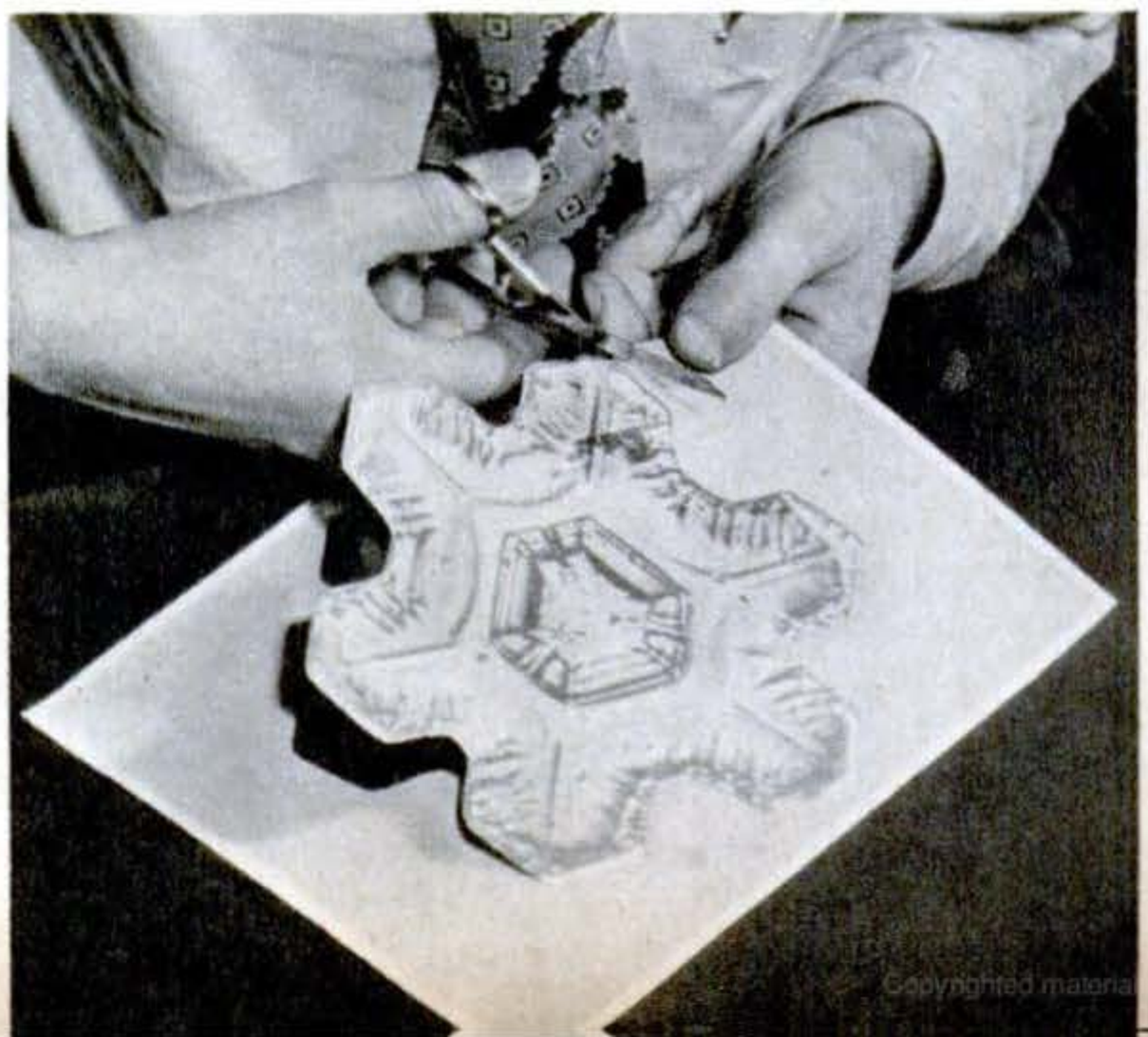
The light rays that pass through a snow crystal in the process of photographing it would quickly melt it if the heat were not extracted from them. This Grafton does by placing a heat-absorbing filter of his own devising in front of the reflector. His filter is a ¼-inch thickness of copper sulphate solution held between two glass disks which are clamped tightly against a rubber gasket.

Grafton's apparatus is ingenious but fairly simple in construction. An upright

5 Film holder is clamped firmly onto camera back, covered with velvet and marked off in squares



6 More depth is obtained by shooting enlarged cutouts under light from a nonreflecting angle



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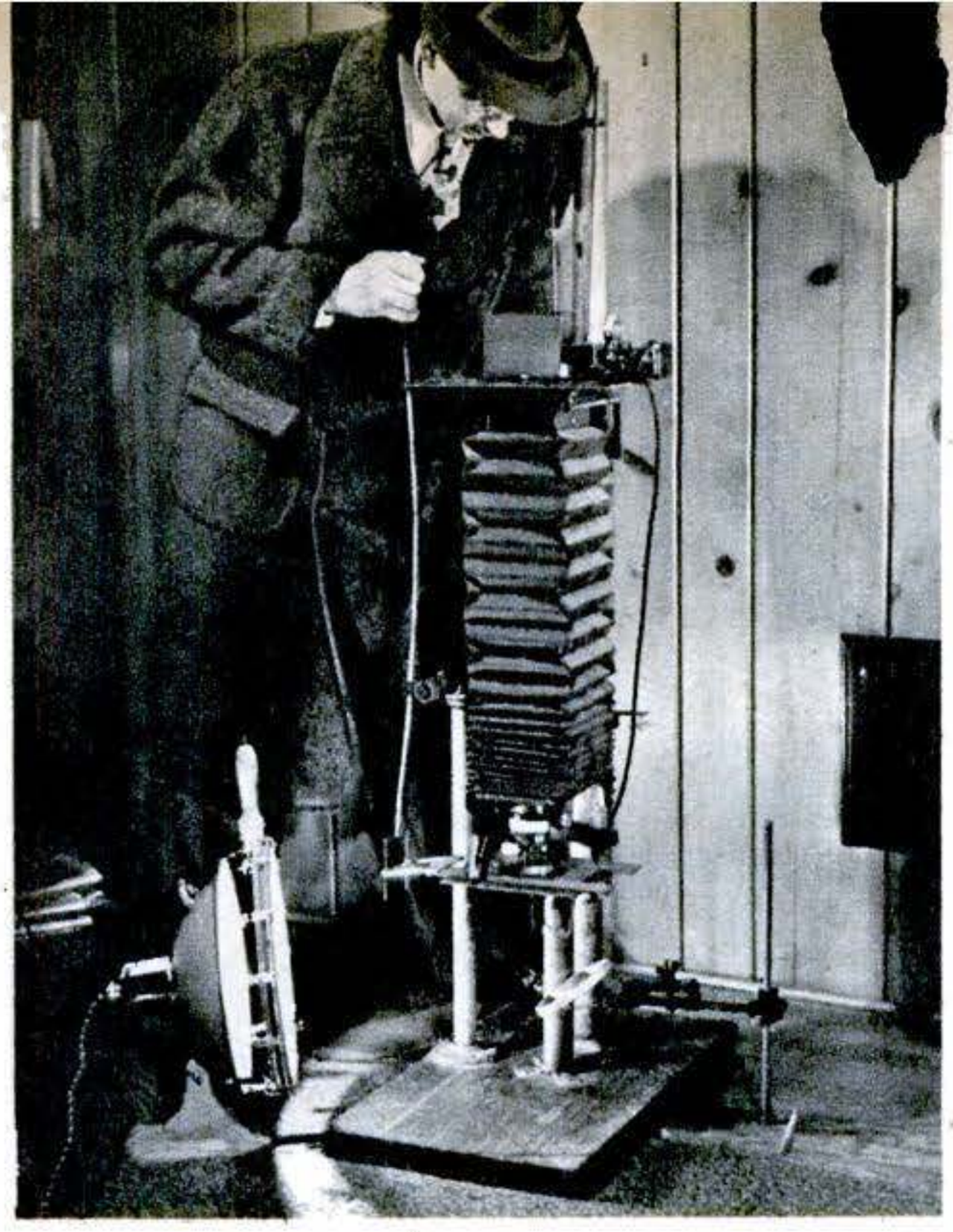
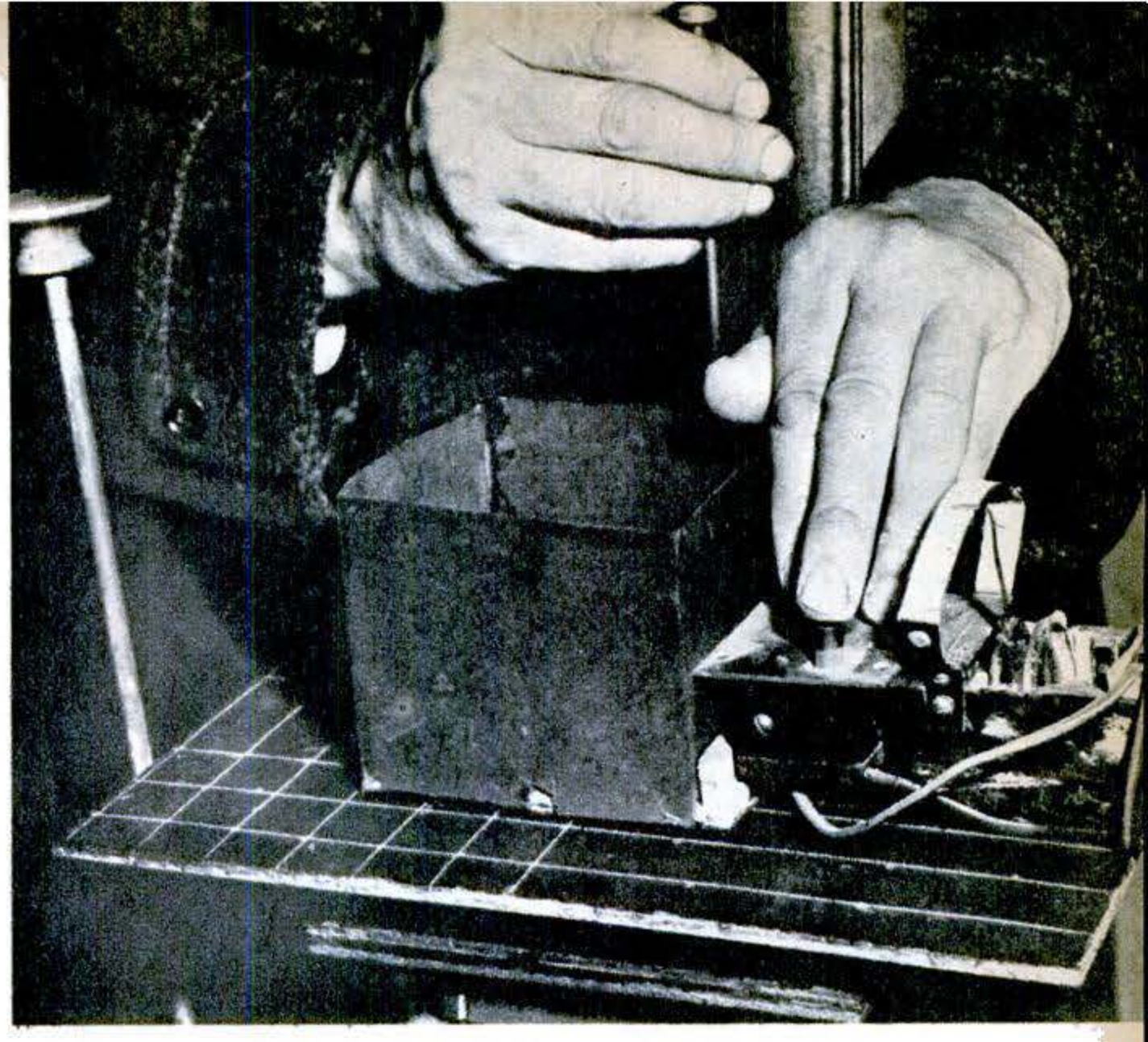


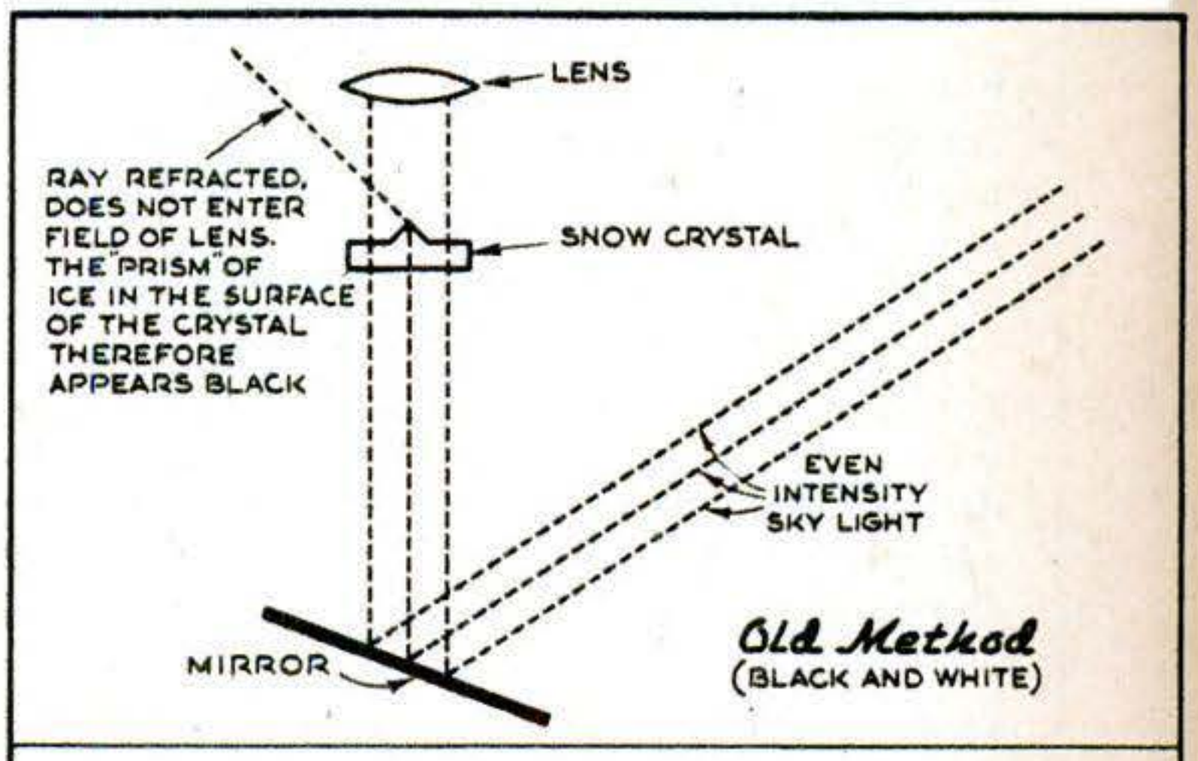
3 The bundled-up photographer moves the subject with a long rod while he views the image on the ground glass



4 Grafton uses his own light meter, which is of the extinction type, having one fixed and one movable polaroid disk. Left hand presses the light switch; right focuses with knob

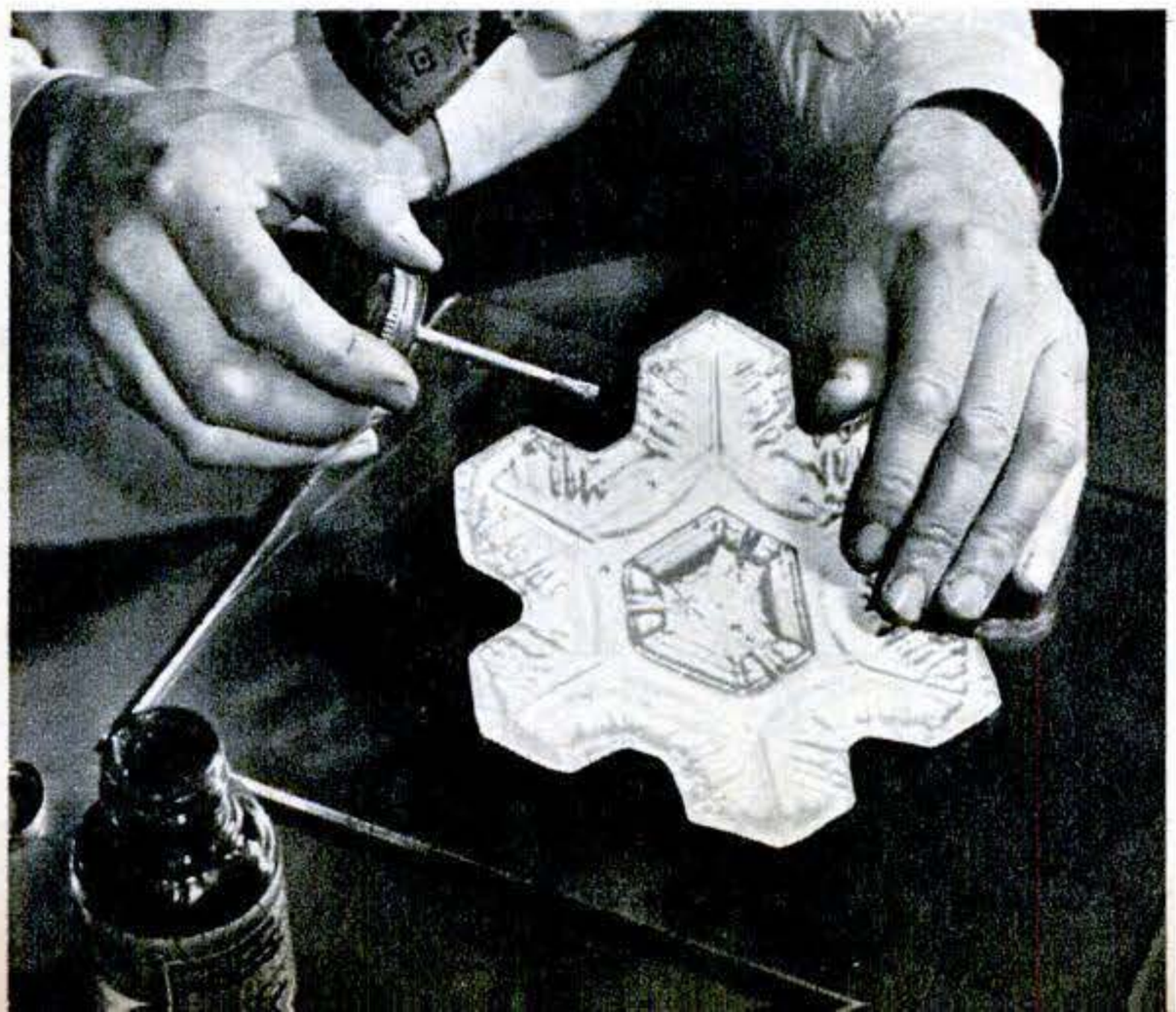
pipe four feet long serves as the backbone to hold the bellows. A threaded rod, with a knob at the top for turning it, makes up his focusing arrangement. Another rod for moving the stage about under the lens also is worked from the top end while the image is being viewed. The camera back is plywood covered with velvet and has an opening one inch square. Grafton has marked off the back into one-inch squares. This enables him to take 20 exposures on a single four-by-five film by moving the holder from square to square.

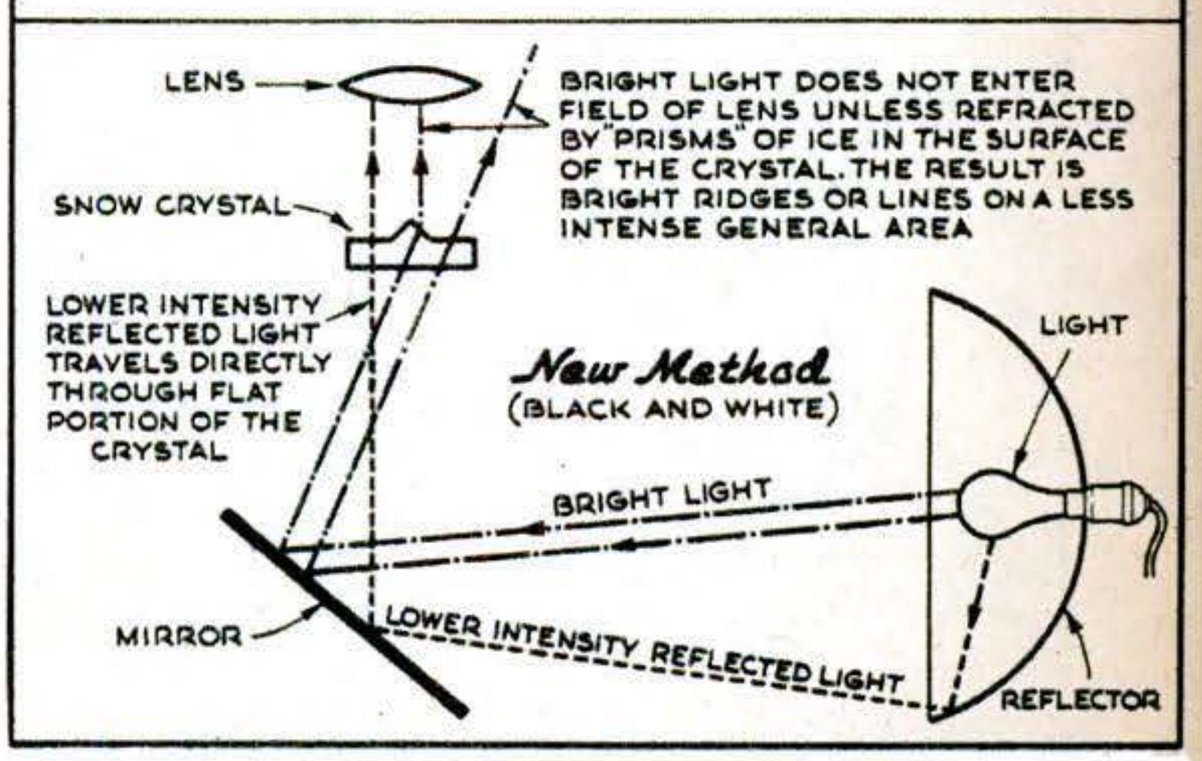
In photographing flowers, seeds, and insects, Grafton obtains unusual lighting effects by placing small pieces of mirror about them to reflect the light. In such cases, tilting the stage would give a double shadow effect. Instead, he moves the lens in a



Upper drawing shows usual method of photographing snow crystals in black and white, and the lower illustrates Grafton's method. The even-intensity light as diagramed above produces the black-line pattern picture, while the refraction of reflected rays from nearer the central light into the field of the lens (below) is responsible for intermediate shades. Bright lines on light-gray background are the result

7 Clipped photo is glued onto glass and put on frame above a black cloth for rephotographing





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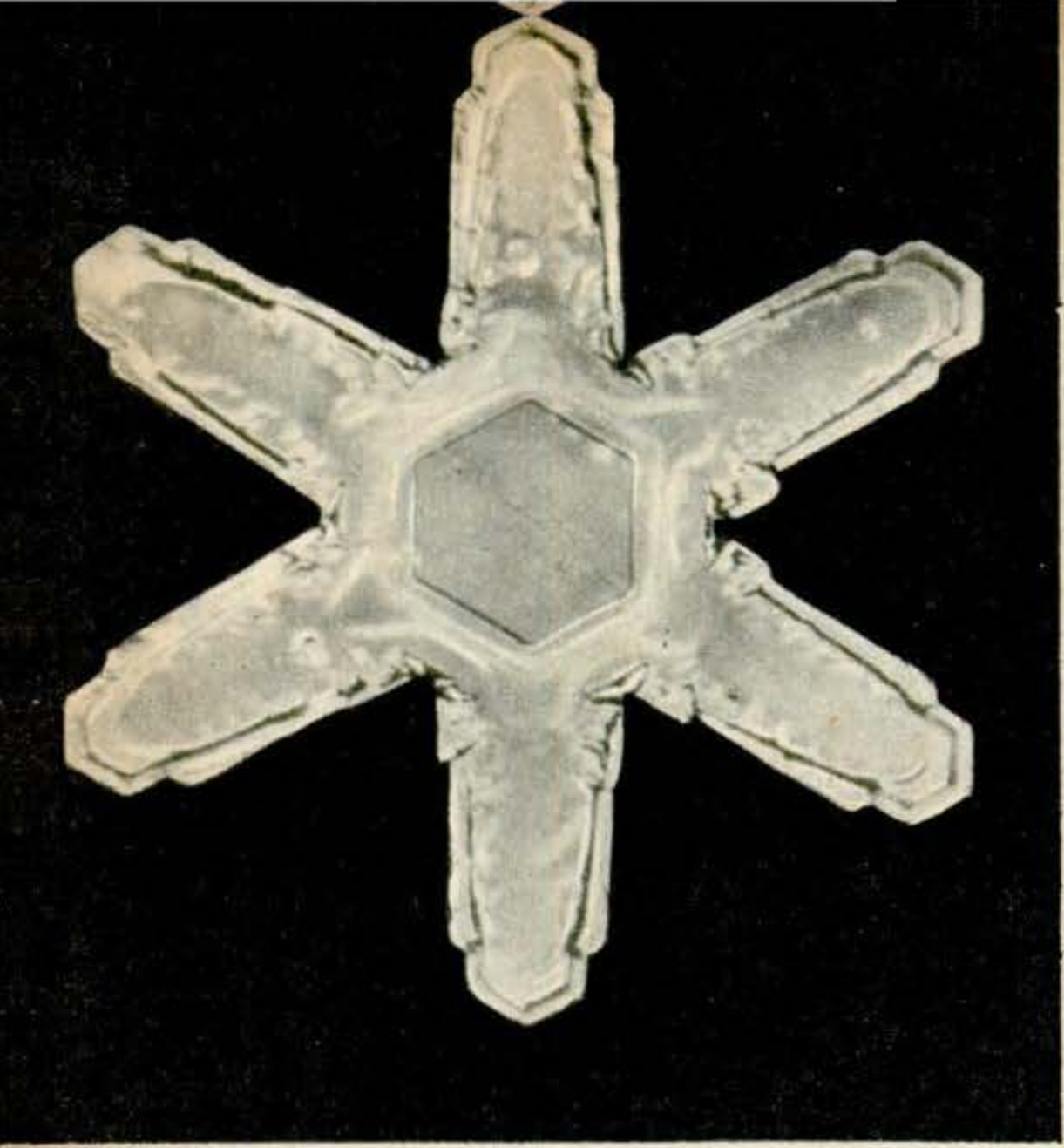
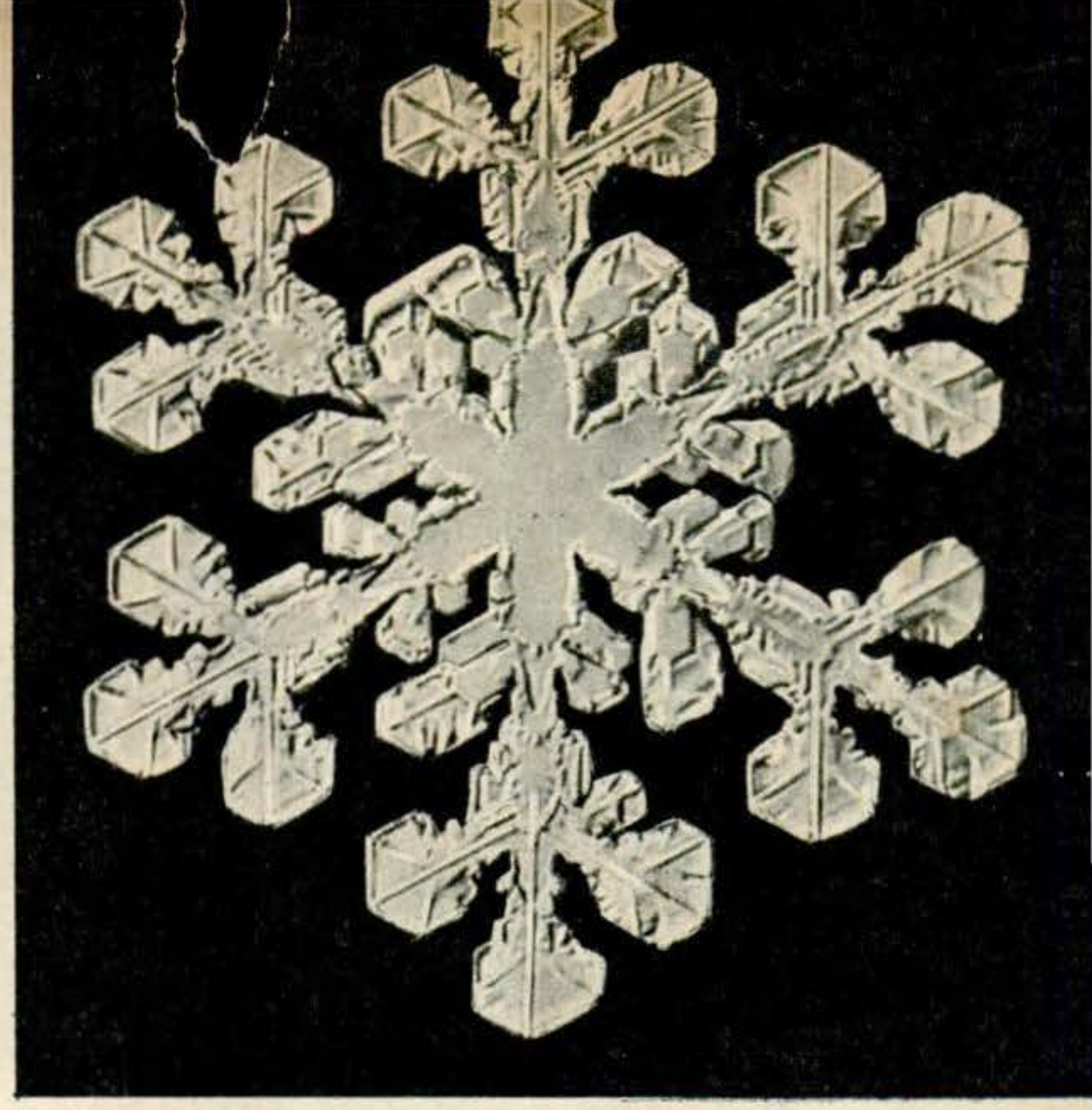


The method of lighting employed by Grafton in taking black-and-white snow-crystal pictures results in the added depth and shadow effect seen here



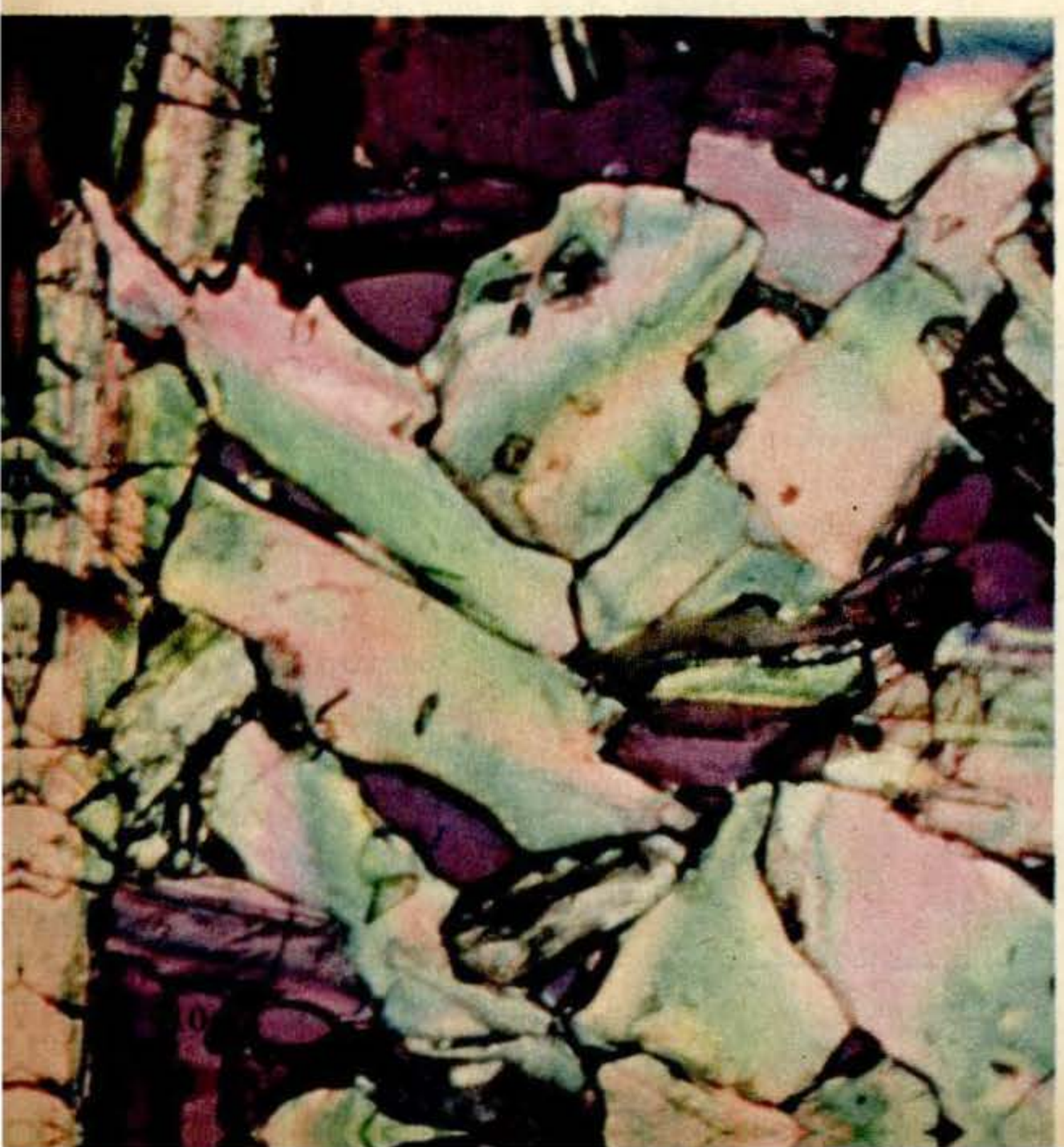
No two snow crystals are exactly alike, although every one adheres to a hexagonal pattern. Grafton says the best specimens come near end of snowfall

horizontal plane. This requires a corresponding movement of the opening in the camera back. So the photographer devised simply operated sliding arrangements for both.

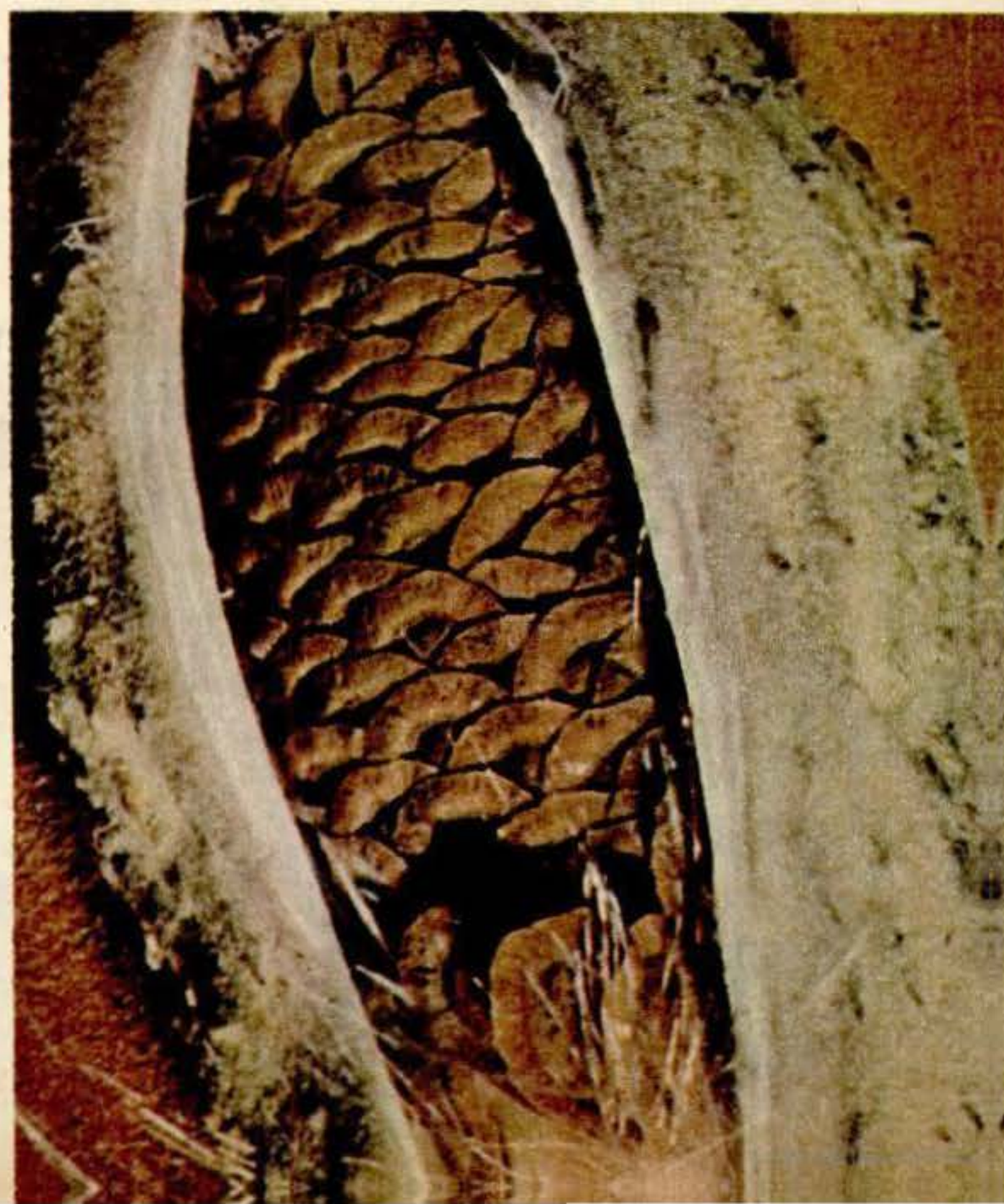
Photography has been Grafton's lifelong hobby. He worked his way through college by taking snapshots for sale and by developing and printing pictures. A chemical engineer, he is research director for the Cordo Chemical Co., Norwalk, Conn. Here, also, his natural inventiveness has made valuable contributions in the field of synthetic adhesives. His technical knowledge was not necessary to his hobby, he says.

In making his snow-crystal pictures, Grafton uses a 32-millimeter micro Tessar and a two-inch Goertz Hypar lens. For other purposes he uses a 16-millimeter microscope objective, a 3½-inch Bausch & Lomb Tessar, and also a seven-inch Zeiss Tessar from his Graflex.

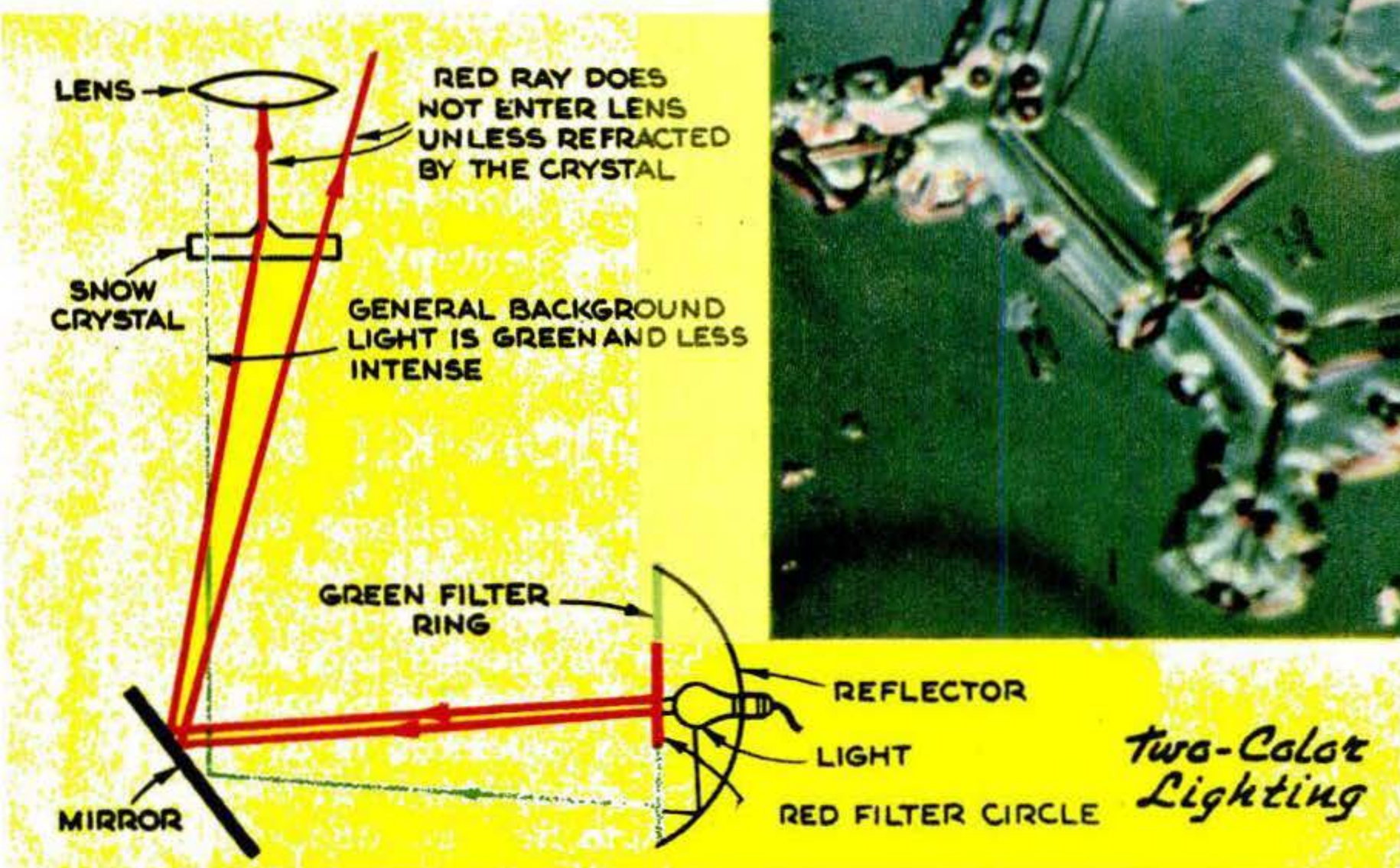
Hydroquinone crystals illuminated with light polarized through a stretched-out polyvinyl alcohol film



Milkweed pod, reduced with enlarging camera by the use of a seven-inch Graflex camera lens

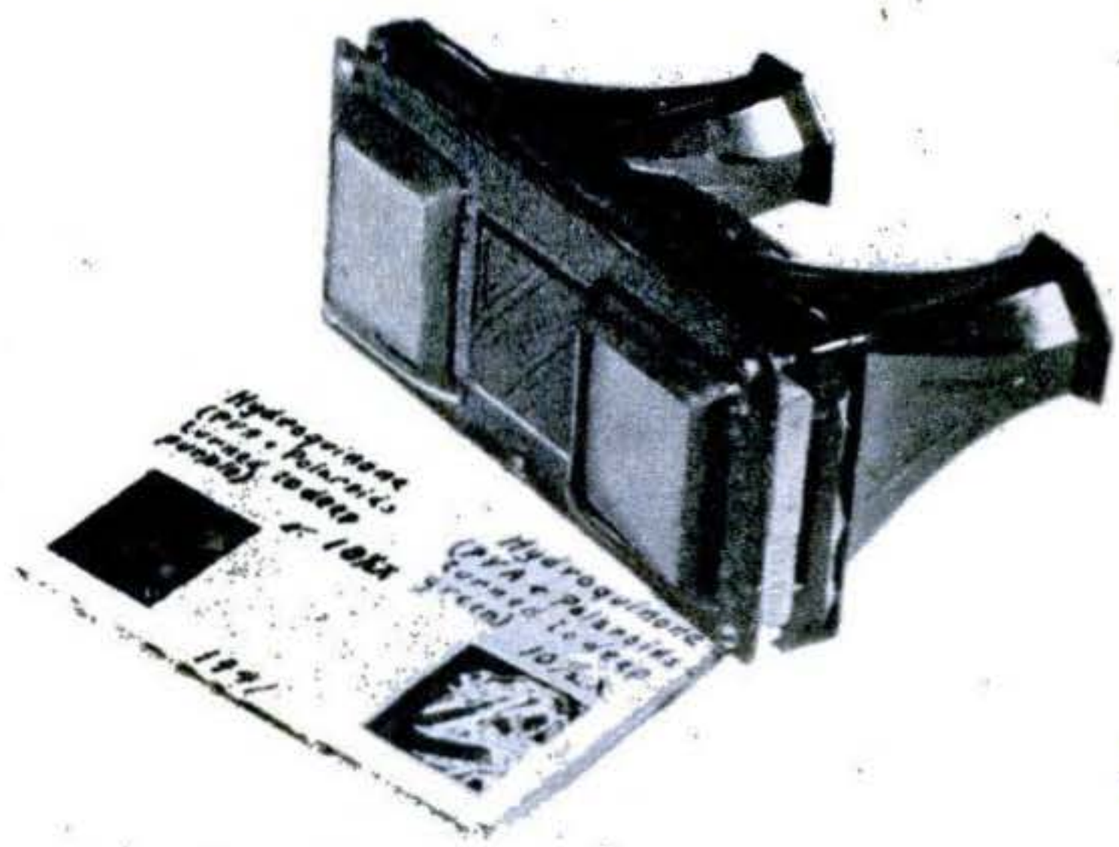


HOW IT'S DONE IN COLORS. Here is another gemlike snow crystal in two colors, with a diagram of the manner in which it was lighted for photographing. Note important differences from diagram at bottom of page 103, which illustrates the Grafton black-and-white method for taking pictures

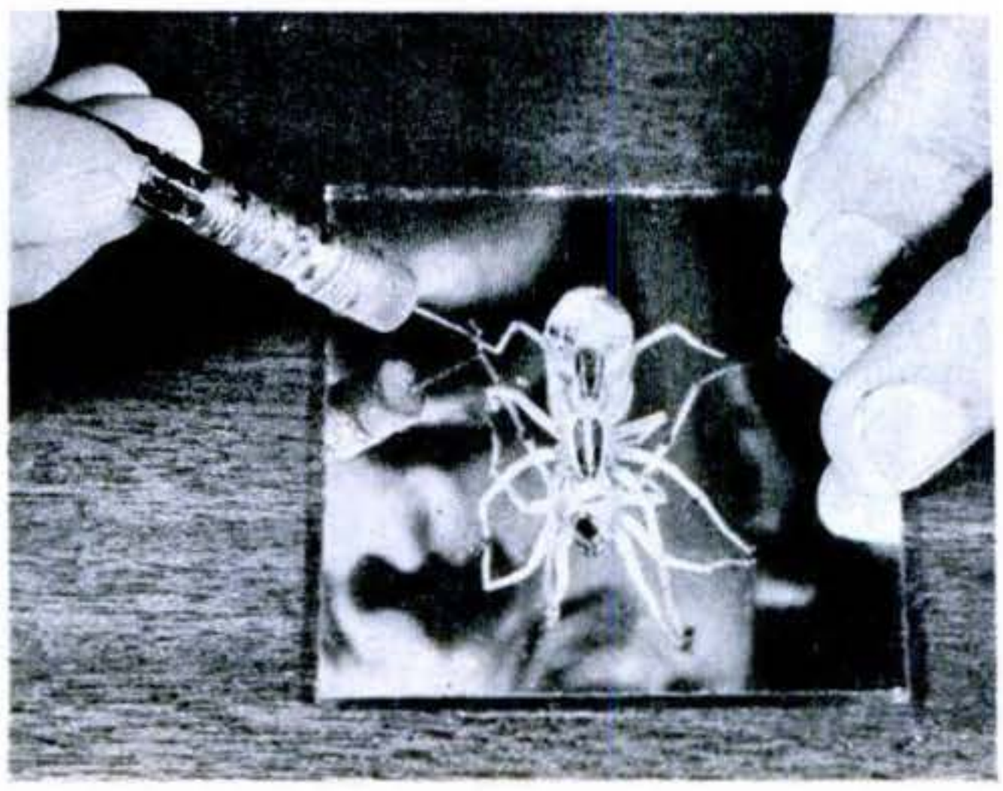


Two-Color Lighting

STEREOGRAPHS ARE VIEWED through this adaptation of a century-old device. To obtain the two different exposures for such viewing, Grafton turns the stage on which his subject is mounted from one to three degrees on its horizontal axis. Thus the three-dimensional effect is given the picture as seen with the stereoscope. Windows in cardboard slides are then cut with a homemade die. Transparencies are cemented between pieces of microscope-slide glass and then into proper relationship in the two windows. Care must be taken to avoid distortion through too wide an adjustment of the camera angle and improper mounting



MIRRORED spider setup is prepared with a mounting instrument composed of a pin stuck into a common pencil rubber and a self-devised colorless plastic cement for fixing the insect's feet to the mirror. Specimen is then placed on revolving stand fixed to a hinged piece, giving unlimited range for angles in photographing



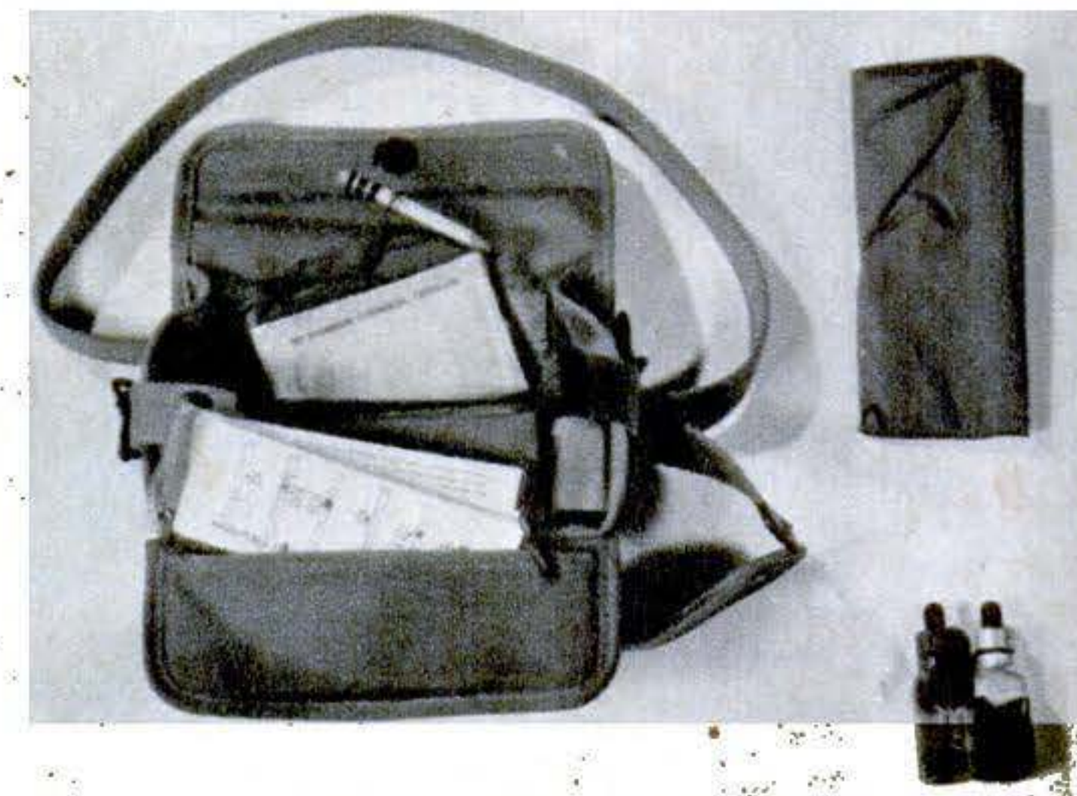
Our Army's Defense Against Poison Gas

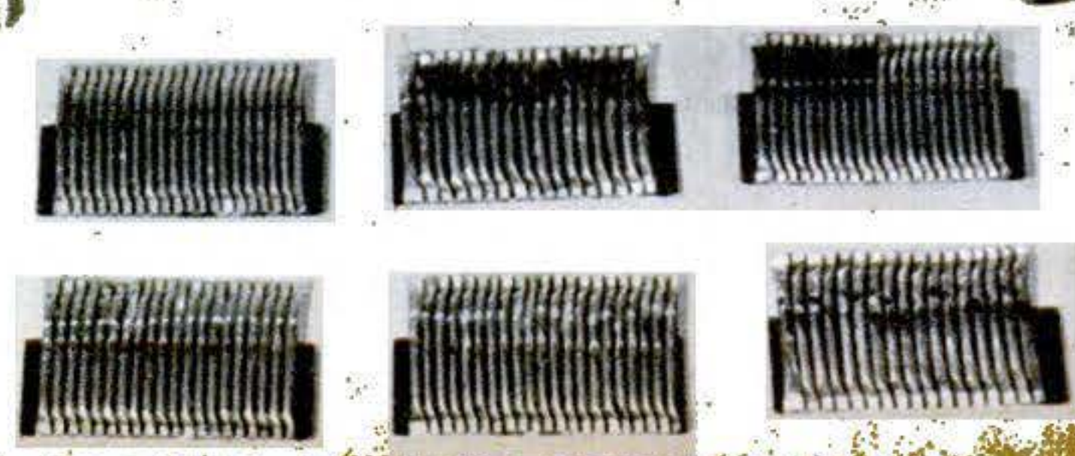
Instant detection, prompt identification, complete protection—that's the Chemical Warfare Service's formula for guarding our GI's against the constant danger of sudden, unexpected, enemy gas attack.

GAS-DETECTION KIT BRINGS

IN SOLVING the two big problems of defense in gas warfare—detecting the gas and then protecting personnel against it—our Chemical Warfare Service has developed equipment that safeguards our soldiers from every war gas now known. One of these detectors is a veritable chemical laboratory which has been condensed into a handy 2½-pound field kit, and which can also be used to identify the gas. Others are chemically treated paper, chalk, and paint that give prompt warning of invading blister gas by a quick change of color. Protective equipment, equally ingenious, includes gas-repellent clothes, impermeable envelopes, neutralizing ointments, and the best gas mask in the world.

The kit, which is placed in the charge of the gas noncom of each company, contains (left to right, top to bottom) suction pump; case containing pencil, note pad, color-guide card, and waterproof envelopes for samples; waterproof covering for the case; four reagent chemicals; six racks of small glass tubes





FROM HEAD TO TOE this Yank soldier is dressed for the dangerous job of decontaminating an area that has been drenched with gas. His equipment includes a gas mask, an impermeable coverall, shoes specially treated inside and out to prevent gas penetration, and heavy gloves, under which he wears a cotton pair treated with a strong repellent. Because this coverall is practically airtight and doesn't allow his body to breathe, he can work in it only for short periods, then comes out for air

By GOLD V. SANDERS

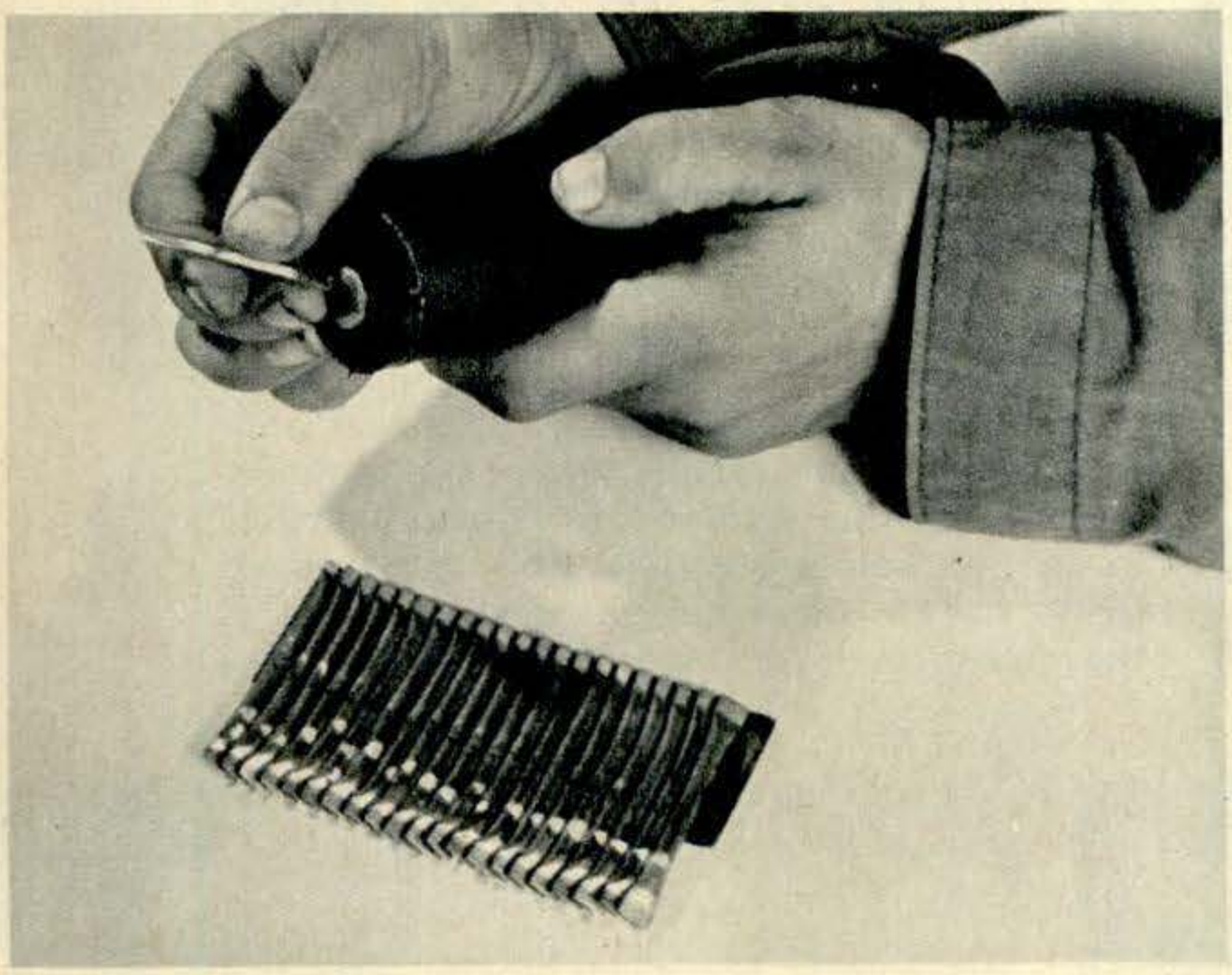
Photographs by WILLIAM W. MORRIS

NO SUDDEN attack with war gas on any front can catch American soldiers defenseless and unprepared as in World War I. No matter what new surprise gas a desperate enemy might spring on us, we can break it down quickly, right in the front lines, and counter it before it can produce disastrous results.

Never forget that the Chemical Warfare Service is right there at the front, too, wherever American soldiers are fighting. Its highly trained experts are a part of every division, of every company. They are eternally sampling the air our soldiers breathe for the slightest trace of poison gas or irritating chemical. And they are superbly equipped, thanks to that same American inventive genius which has given us the world's best offensive weapons and other tools of war.

A marvel of ingenuity and simplicity is the miniature gas-detection kit pictured on these pages. One of these goes along with every company into battle, handled by a man trained in the Chemical Warfare School. Weighing only 2½ pounds, it is so cleverly worked out that it can detect and identify any of the known war gases in a few seconds, right on the spot. If a gas should be found which is not identifiable, a sample of it can be taken up from the air with one of the prepared glass tubes and then sent promptly to the laboratory

CHEMICAL LABORATORY TO FIELD OF BATTLE



One of the glass tubes is inserted in the end of the suction pump. Containing silica gel, it will absorb gas from the air that is sucked through it. A drop of the right reagent will produce a telltale color

Here the pump is ready for action. By comparing color of "gassed" silica with color guide, gas is easily identified. In some cases a gas will produce characteristic color without aid of reagent

Besides the four bottles of reagents shown in the photograph at left there are three tubes of reagents, which fit compactly in the hollow handle of the pump

Chemical warfare has thought of everything, including a flashlight (with waterproof switch) in the handle so that the tests can be made at night

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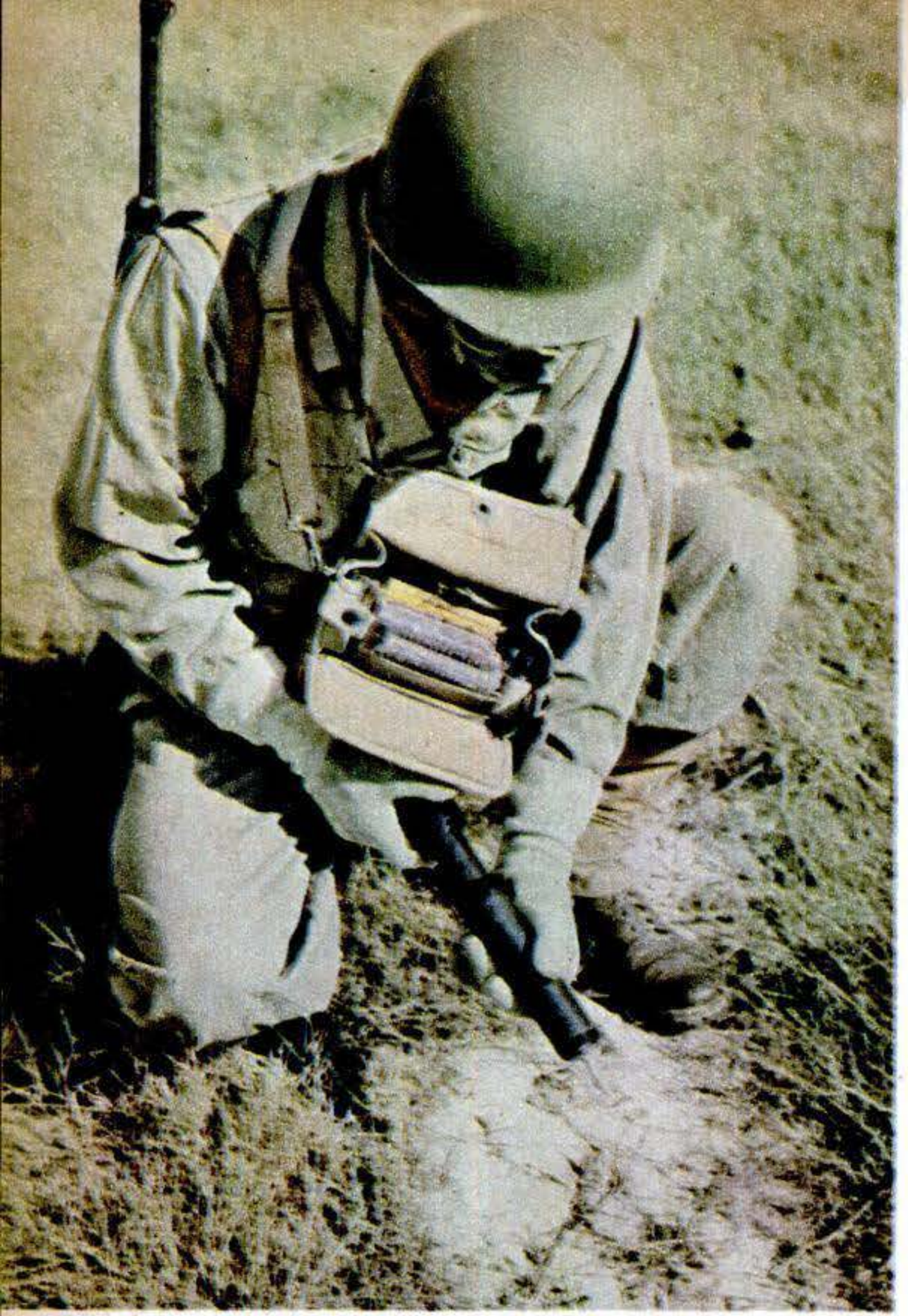

SAMPLING THE AIR for gas, the suction pump is held close to the ground where the gas concentration is strongest. If the enemy springs a new gas, special glass tubes can be used to capture a specimen, which is then sent to a field laboratory for analysis

for immediate analysis by its chemists.

Detecting the presence of gas is, of course, the first essential in defense against it. Foolproof and positive as the detection kit is, it is not necessarily the first device to discover an attack. A soldier's helmet may suddenly blossom out with fiery red spots, a warning that the enemy has let loose blister gas. The helmet is coated with gas-sensitive green paint, developed by the Chemical Warfare Service. Every drop of vesicant gas that touches it will produce a flaming danger signal in five seconds. Every soldier knows what it means. The warning gong is sounded and the whole unit can be protected from the miseries produced by these irritating chemicals. The same paint may be used on vehicles or equipment.

A similar protective device consists of gas-sensitive cardboard, colored green and cut into small squares. This can be used in countless ways; laid on the ground, fastened to vehicles, pinned to uniforms, tacked on fences. Droplets of blister gas make red spots here, too. Still another innovation is chemically treated crayon to be used in marking vehicles and equipment. It is bright pink and turns blue on contact with the poison stuff.

One man in each company or equivalent unit carries a special gong to be used only to sound a gas alarm. When this sounds, every front-line soldier knows exactly what to do for self-protection, and is equipped to do it. He dons his gas mask, which is the finest ever devised. His special-issue

PAINT that a GI can daub on his helmet (above) or any other handy surface enables him to do his own gas-detecting. Olive drab in color, the paint will turn to a flaming red (left) five seconds after it comes in contact with even the lightest concentration of any one of the three known blister gases. The instant the GI gets a "red light," he knows it is time to don his mask and gas-repellent clothes

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PAPER SHEETS, greenish in color and chemically treated, are another means of warning soldiers of the presence of gas. One drop of a vesicant, and a brilliant red spot appears. The sheet can be worn on the arm, tacked to a fence, stuck on the end of a bayonet, or put any other place where it will be easily seen. Near one corner of the sheet is a small hole. Should a drop of liquid gas larger than this hole appear on the sheet, it will mean that the concentration of gas is too strong for his clothes and the GI had better get under his plastic envelope

uniform is impregnated with a chemical that neutralizes blister gases in any ordinary degree of concentration. Underwear, socks, shoes, gloves, and a special hood all are similarly treated. With all of this carefully buttoned up, the soldier is practically immune to blistering chemicals, but he also has in his gas-mask case two plastic envelopes large enough to cover him completely if there should be a heavy fall of liquid poison from airplanes. Furthermore, he can push his gun muzzle through one corner and keep on shooting.

If blister gas has reached the soldier's skin in spite of all these protective measures, he has in his kit tubes of ointment that will neutralize it if used in time.

These are the protective means used in the field by individual soldiers in the midst of combat. It is only one

CHALK MARKS also play their part in warning troops that gas is in the area. Specially treated, the pink chalk, when drawn on a surface on which there is only a slight amount of blister gas, will quickly turn to a bright blue. If it is rubbed across a dry surface and then wetted with even an extremely small concentration of a vesicant, the same change of color will take place

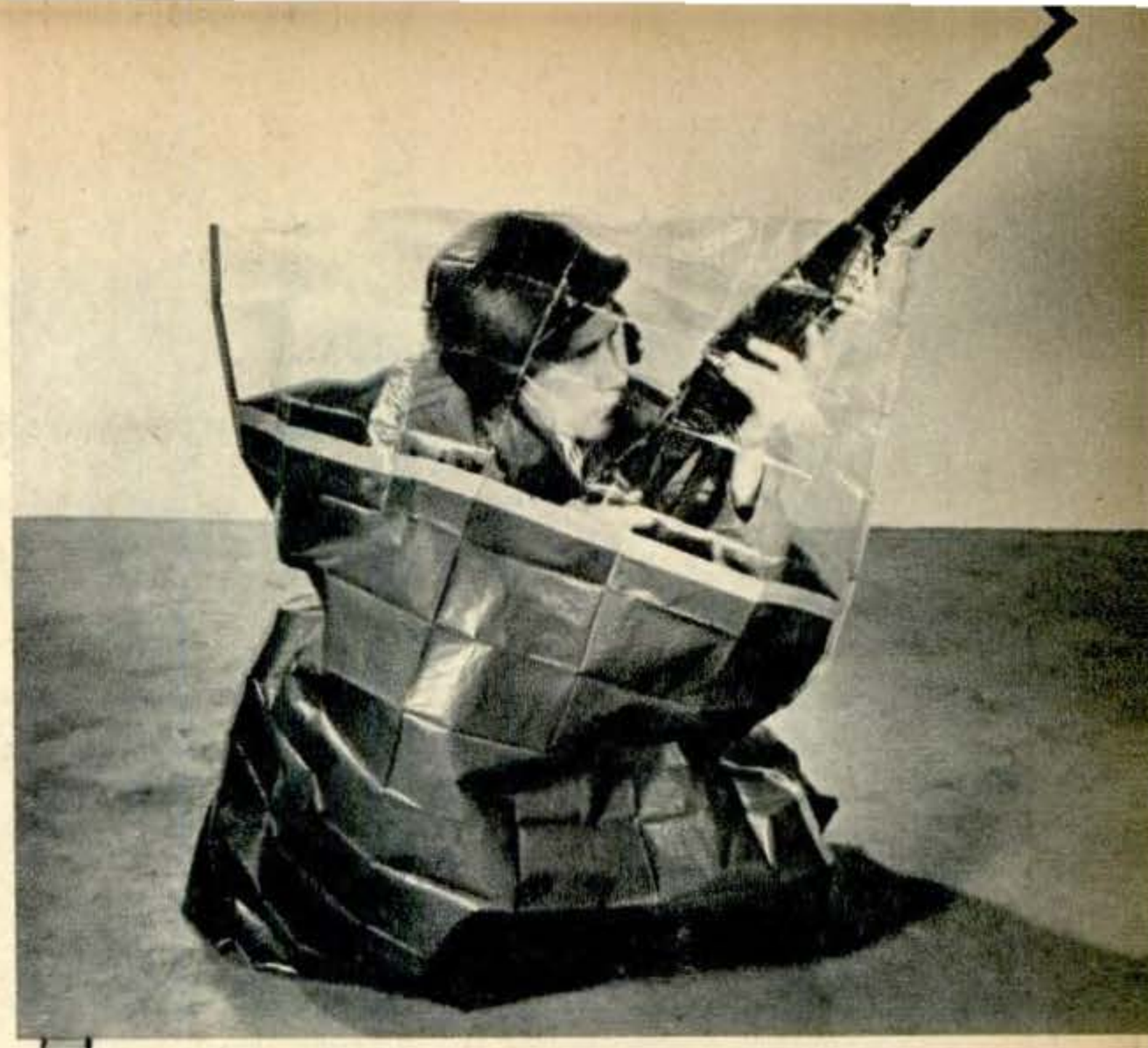
PROTECTION for American soldiers against skin-scorching vesicants and deadly gases that attack the lungs is provided by gas-repellent clothing and the finest gas mask in the world. If a GI is operating in an area where he might be subject to a gas attack, he dons underwear, socks, coverall, and shoes, all of which have been specially treated to resist blister gases in ordinary amounts. In the event of an attack, all he then needs to do is to put on his mask; don a protective hood (above) that fits over his head, around the edges of the mask, and down over his shoulders (below); and pull on a pair of heavy gloves. From the skin out, the GI's clothing is designed to give complete freedom of movement, and to keep out gases while admitting sufficient air for the body to breathe

part of the elaborate system of preparation worked out by the Chemical Warfare Service with full co-operation from our gigantic chemical industry.

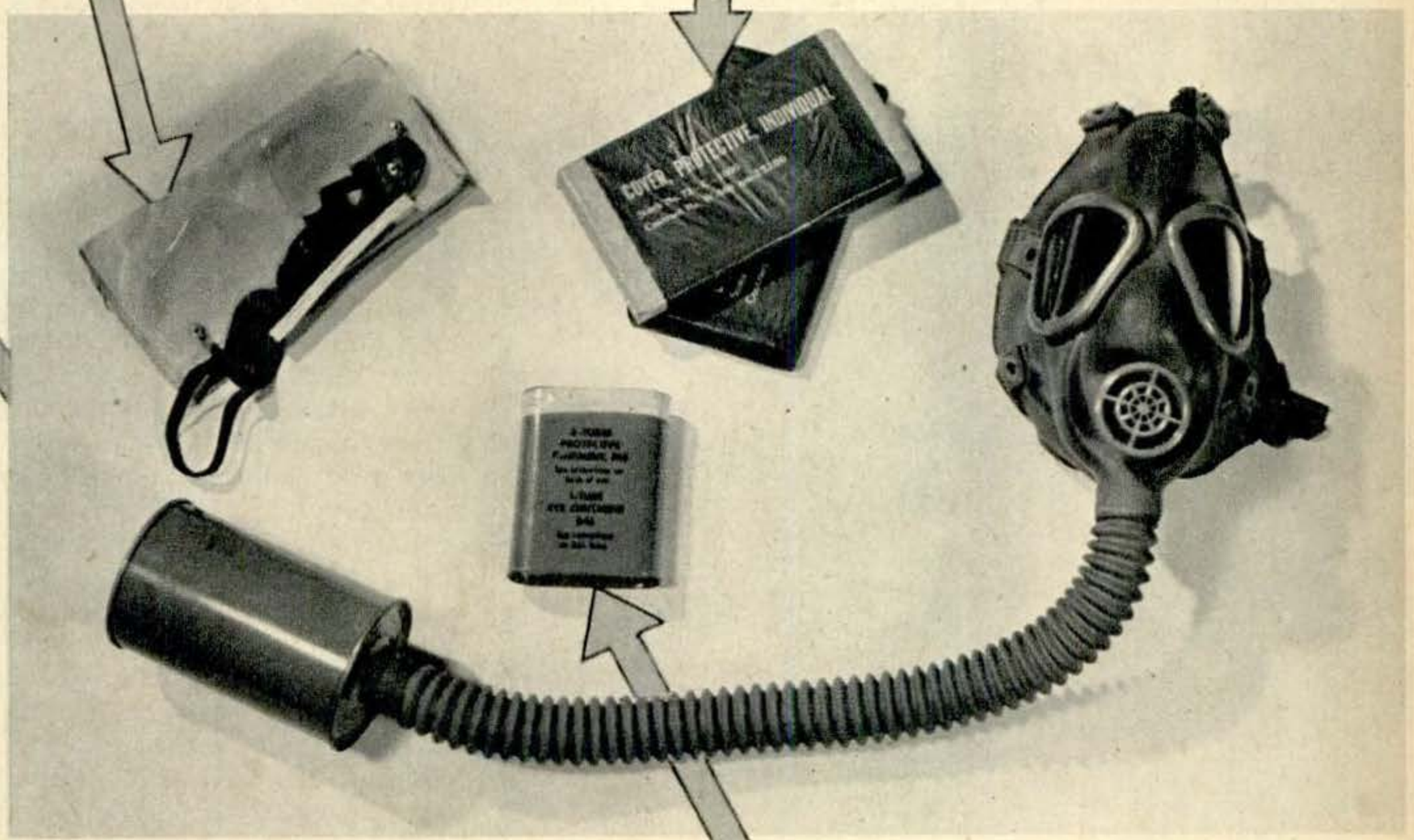
There are also gasproof field shelters in which staff officers can work with complete protection from gas attack. Immense "breathing machines" inhale the poisoned air from outside and exhale purified air into the shelter, which may be either a standing building or a portable structure.

The Chemical Warfare Service also has the responsibility of preparing for retaliation, and it has been stated frequently, for the benefit of the enemy, that we are fully equipped in this respect.

EYE SHIELD, snug-fitting and made of plastic, is always worn in areas where there is a danger of gas which may be as yet undetected. It also serves to protect the wearer's eyes in the event of surprise attack



PROTECTIVE COVER, under which a soldier can crouch, offers protection from gas in any liquid concentration. While the cover limits his mobility, the GI can shove his rifle through an opening in one corner and keep on peppering away at the enemy



GAS-MASK CARRIER holds an eye shield, two protective covers, a can with three tubes of ointment for blister gases, and the mask itself, with hose and air-purifying canister attached. All fit compactly in the carrier shown in position at left

OINTMENT neutralizes vesicants and prevents painful blistering of the skin. GI's are taught not to be misled by gases that do not burn at first. Ointment must be used immediately after contact, else it may be too late

"Green Gold" OF WYOMING

How prospectors are finding a fortune in boulders of high-grade American green jade.

A small, light-green rock sticking above ground, when finally unearthed, turned out to be this 3,366-pound boulder of solid jade. Prospectors, still not fully convinced of the value of the rocks they've been kicking around for years, pile 'em up carelessly in back yards (below)

When Bert Rhoads found this 125-pound piece of "green gold," he turned prospector and jade carver

FORTUNES lying around loose on the ground in Wyoming have been passed up by generations of residents with no more than a casual glance. Now those green rocks, scattered at random among the sagebrush, have turned out to be nothing less than jade. The rush for the "green gold" is on—and some of it is actually worth more than gold, ounce for ounce. Substantial citizens are giving up regular occupations to hunt the green stones over the wastelands of the Sweetwater country. Some have already become fairly wealthy.

This is the first substantial find of jade in the Western Hemisphere and it is an immense one. The jade area is at least 600 square miles in extent, and possibly much greater. Only the surface has been touched. Jade prospecting up to now has been

Salt and pepper shakers and wine glass made by Bert Rhoads, and a partly worked piece, show wide color variation of Wyoming jade

Here are some fine examples of Wyoming jade jewelry. Pendant was cut and polished by James L. Kraft, cheese manufacturer, who has made a hobby of collecting and cutting jade. The bracelet, eardrops, and ring are the work of Bert Rhoads. Establishment of jade cutting as an American art will provide a new outlet for native creative talent and may give China some stiff competition in the postwar jewelry market

In color, jade ranges from black to white, although it is best known for its rich, beautiful shades of green. These pendants, with the exception of the heart, cross, and teardrop, were cut and polished by Kraft, whose interest in the mineral took him to the town of Lander where he helped to convince the local townspeople that a fortune lay at their feet

Wyoming has a lot of rocks, but not all of them, like these two, are worth over 15 dollars a pound

Larger of these jade pieces, weighing 2,400 pounds, was presented by Mr. Kraft to a Chicago museum

merely a matter of roaming the countryside and picking up those green pebbles, chunks, and boulders that are in plain sight. Some have been so polished by the elements that they look as if they had been painted and laid out to dry. Others look much like ordinary stones until a piece is chipped off with the little prospecting pick the jade hunter uses. Of these there is doubtless an immense amount to be discovered, not to mention what is under the surface. No vein or mother lode has been found.

Two women, hunting the precious stones near the town of Lander, spied a nice, light-green one partly hidden by a clump of sagebrush. It was about the size of a man's hat—they thought. They tried to loosen it from the earth but it wouldn't budge. They dug with their picks, and the more they dug the larger it grew. They hurried back to bring their husbands and a big wrecker. After hours of digging and hauling, the two men got it out—3,366 pounds of high-quality jade, a fortune for two families.

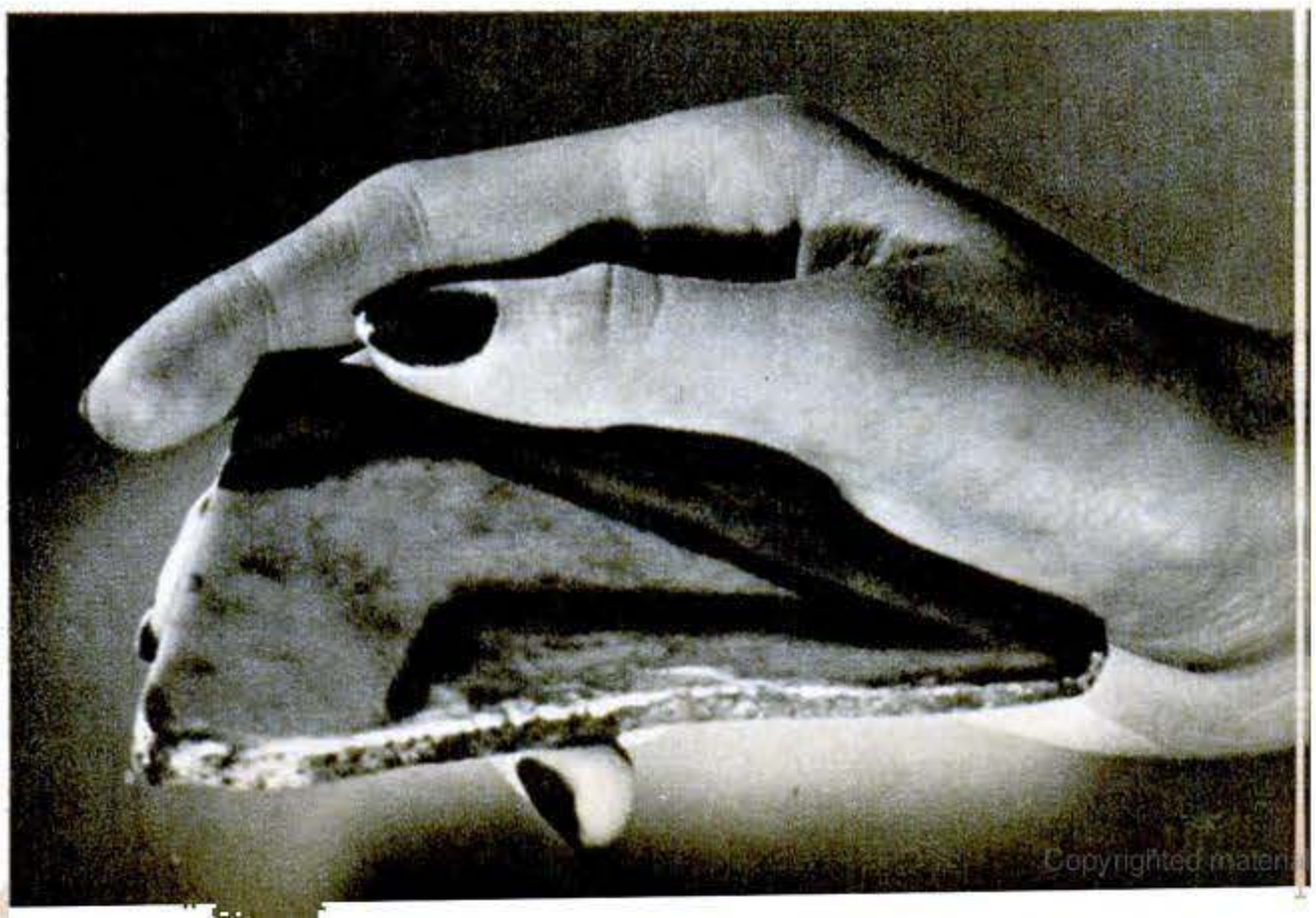
There have been other finds almost as sensational. Allan Branham, manager of a grocery store in Lander, discovered a hunk of jade weighing 2,410 pounds. It was bought at once by James L. Kraft, cheese manufacturer, who donated it to the Field Museum (now Chicago Natural History Museum). Mr. Kraft is a jade hobbyist and has been collecting and cutting the mineral for years. He heard of the Wyoming discoveries and went out to investigate. His visit was a big factor in awakening the local citizens to the immense value of their newly revealed mineral wealth. He told them the jade found there was as high in quality as any that comes from China.

Allan Branham gave up his position and now devotes his time to prospecting for jade. Among many others, he found another huge boulder which he has sold to a Chinese buyer. Other Chinese jade experts have come and bought tons of Wyoming jade, though it cannot be shipped to the Orient until after the war.

Bert Rhoads, proprietor of a furniture and hardware store in Lander for the past 20 years, got hold of some cutting and polishing equipment and started making pendants, crosses, and cabochons of the jade, just as a hobby. He found he could sell all he made at *(Continued on page 208)*

Chinese connoisseurs following the green-gold rush were quick to buy this piece for postwar shipment

Characteristically odd in shape and color is this nugget picked up by a Wyoming "rock hound"



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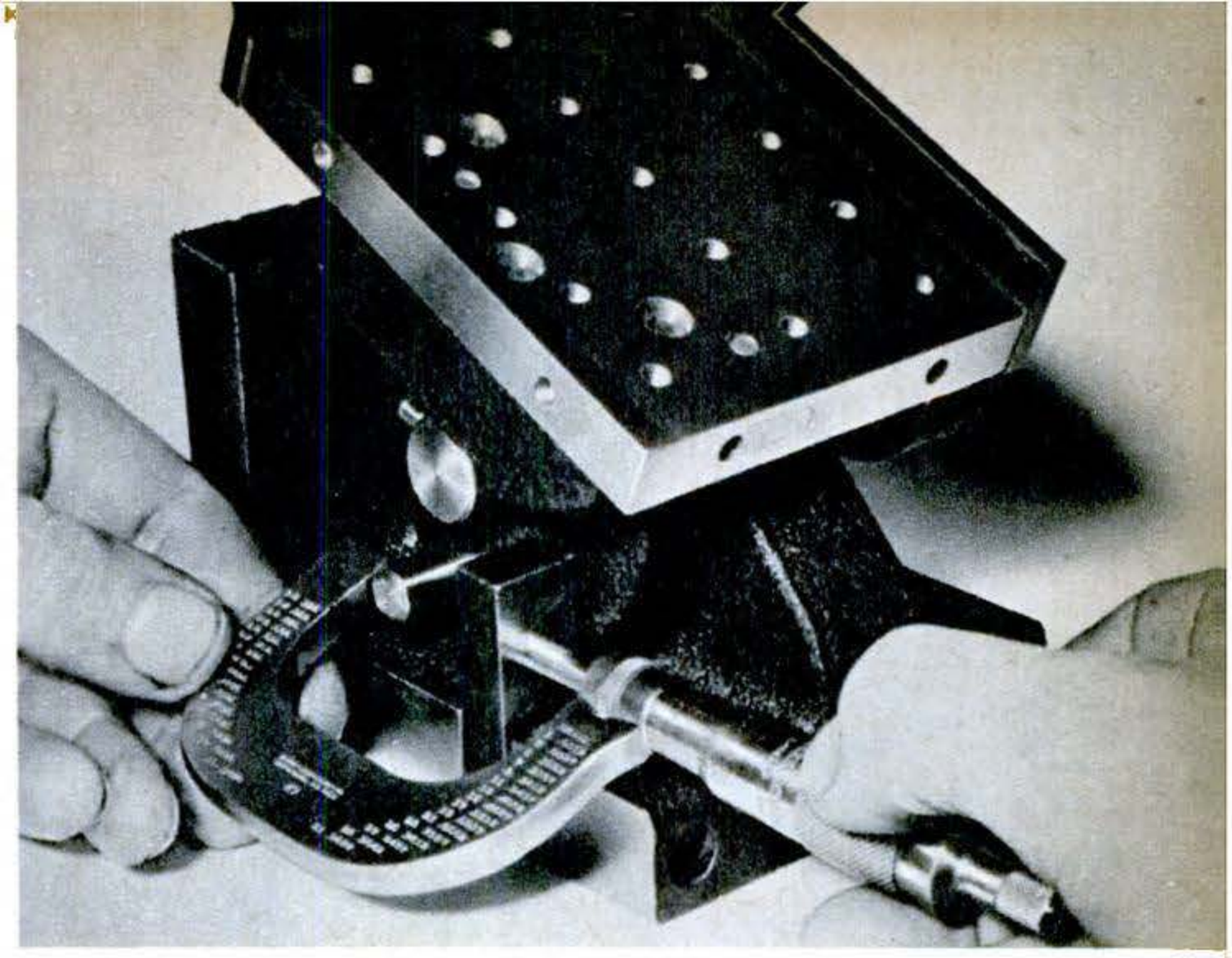
NEW Tools

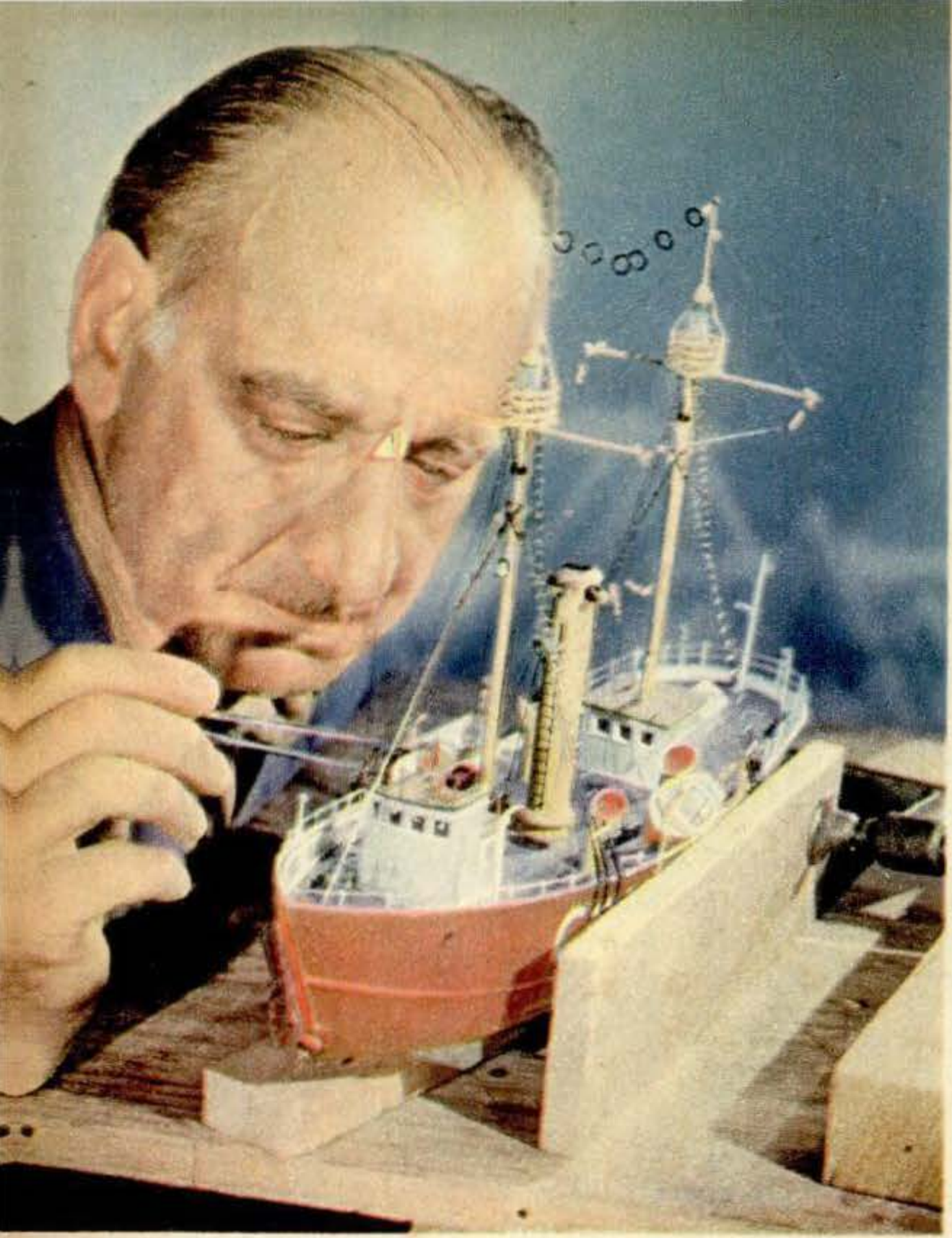


ACCURATE ANGLES to 90 degrees may be set or measured quickly with the aid of the Bemisine, a toolmaker's accessory with provision for holding small work pieces for grinding, machining, and inspection operations. The Bemisine needs only a two-inch-capacity micrometer and the standard table of sines and cosines to set any angle in its range in a minute of time and within an angular minute of accuracy. Illustration shows micrometer over a hardened measuring pin and block. When the work table is level, the distance over the pin and block is one inch; when it is tilted, the pin changes its distance proportionately. A micrometer reading taken over the pin and block at any point (minus the one-inch constant) is the sine reading of the angle.

THREE-WIRE PLUG and suitable ground connections for electric soldering irons made by the Hexacon Electric Co., Roselle Park, N. J., minimize the possibility of shocks and blown fuses. Used only where three-wire outlets are available, the third prong establishes connection between the ground and the outer housing of the soldering iron.

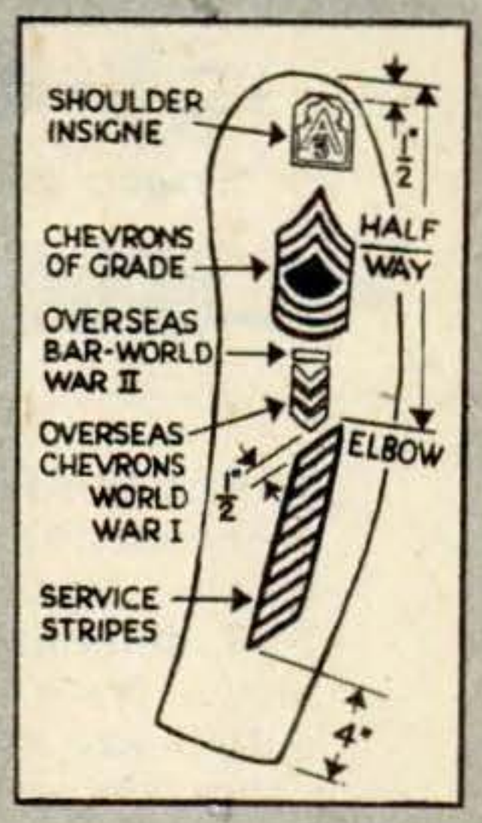
BROKEN DRILLS, formerly thrown into the discard, can now be used if one has a set of Drill-Savers, made by the C-B Tool Co., Lancaster, Pa. The broken end of the drill is slipped into a slot that compresses when the Drill-Saver is in a chuck, and two dimples, which ride in the drill flutes, hold the drill firmly against turning.

SAWING OR FILING of metal, plastics, or wood may be done with the aid of a device called Saw-Chief, which is attached to any electric drill with a ¼-in. chuck, or to a compressed-air line or flexible shaft. It is made by the Chicago Precision Equipment Company.



LIGHTSHIP MODEL, one of a ship series that will appear in an identification film, reproduces in miniature one of the U. S. Coast Guard lightships that are used on the Columbia River in Oregon and Washington. So nearly complete is the model that the smallest visible detail is included. The single funnel is even equipped with faithfully reproduced fog horns. The man who made the model is Fred Malatesta, who has done similar work for George Pal Productions, Inc., Hollywood, Calif. The board set up beside the ship model was placed there purposely to hide the name on its side, for reasons of military security.

GOLDEN BAR, shown just below master sergeant's chevrons, is a new device authorized by the War Department to indicate each six months' service in the Army outside the continental limits of the United States. For purposes of the award, Alaska is included in its scope. Nine diagonal stripes at lower end of sleeve indicate 27 years of service. These insignia might seem to rate salutes from a general or even a second lieutenant.



DIAL THE WEATHER if you're planning a trip. An improved model of the Weathercaster, recently put on the market by the Kenyon Instrument Co., Huntington Station, N. Y., predicts weather conditions with some accuracy as far as a day ahead. It consists of an instruction book with four movable graduated disks of successively larger diameter on the cover. With reference to barometer readings and the direction of the wind, simple adjustments of the disks will reveal what may be expected.

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COLOR SPEEDS PRODUCTION in plants making war materials. The Kodachrome above shows a toolmaker at Northrop Aircraft, Inc., Hawthorne, Calif., reworking an inner wing-frame assembly jig for a Black Widow. The colors are used to indicate the different drill sizes necessary for the job. Also guided by color, young women at Electric Auto-Lite Co., Port Huron, Mich., make the complicated wiring setups for war vehicles. These ignition harnesses are assembled from racks holding miles of varicolored wire, cut to size and with terminals soldered on. A complete harness may require more than two dozen wires, each a different color and sometimes as long as 30 feet. Not only must the right wires be selected, but they must be assembled so the terminals stick out in the right places.

A RARE BIRD, and a beautiful one, too, is the scarlet cock of the rock, of South America. It is native to the rainy uplands of the Ecuadorean and Colombian Andes. This male specimen, about the size of a small pigeon, is one of a pair recently brought to the National Zoological Park, Washington, D. C. The female's color is brown.

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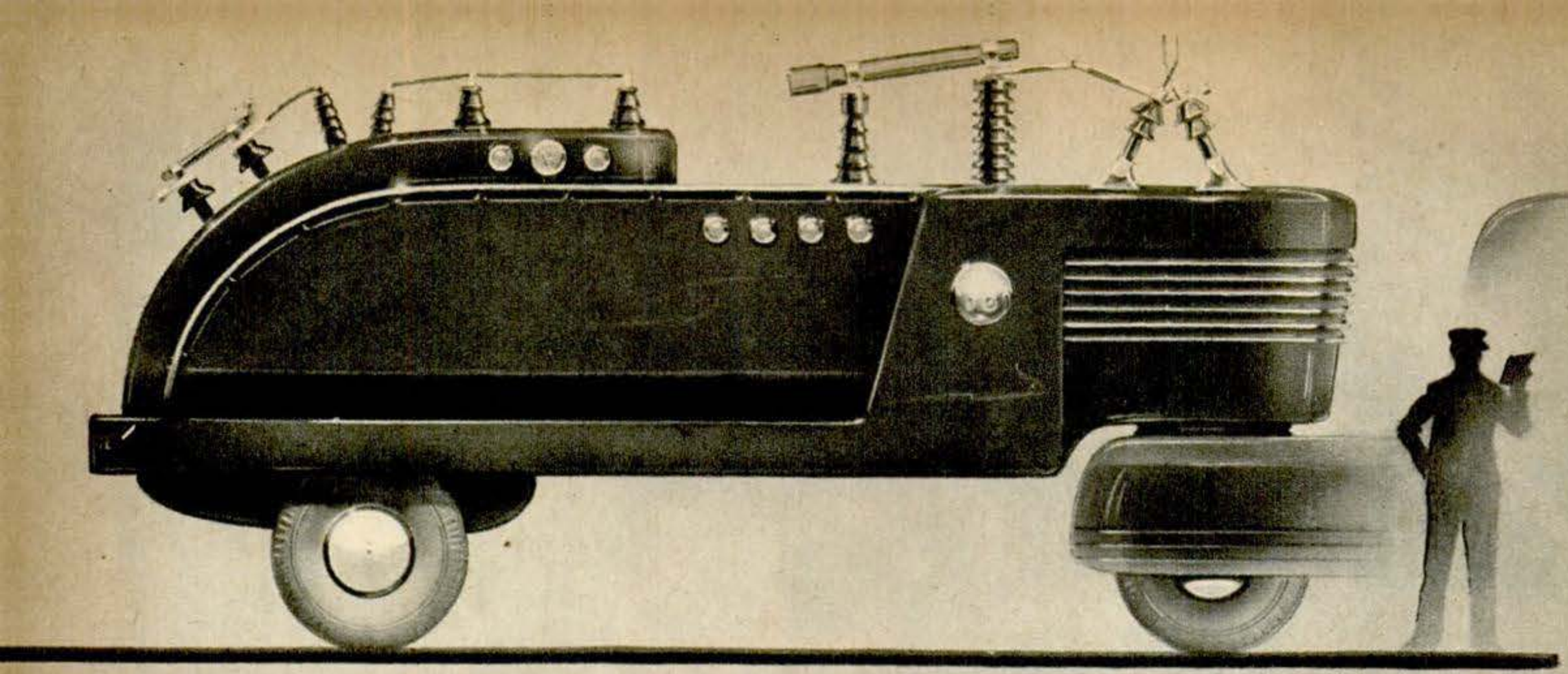
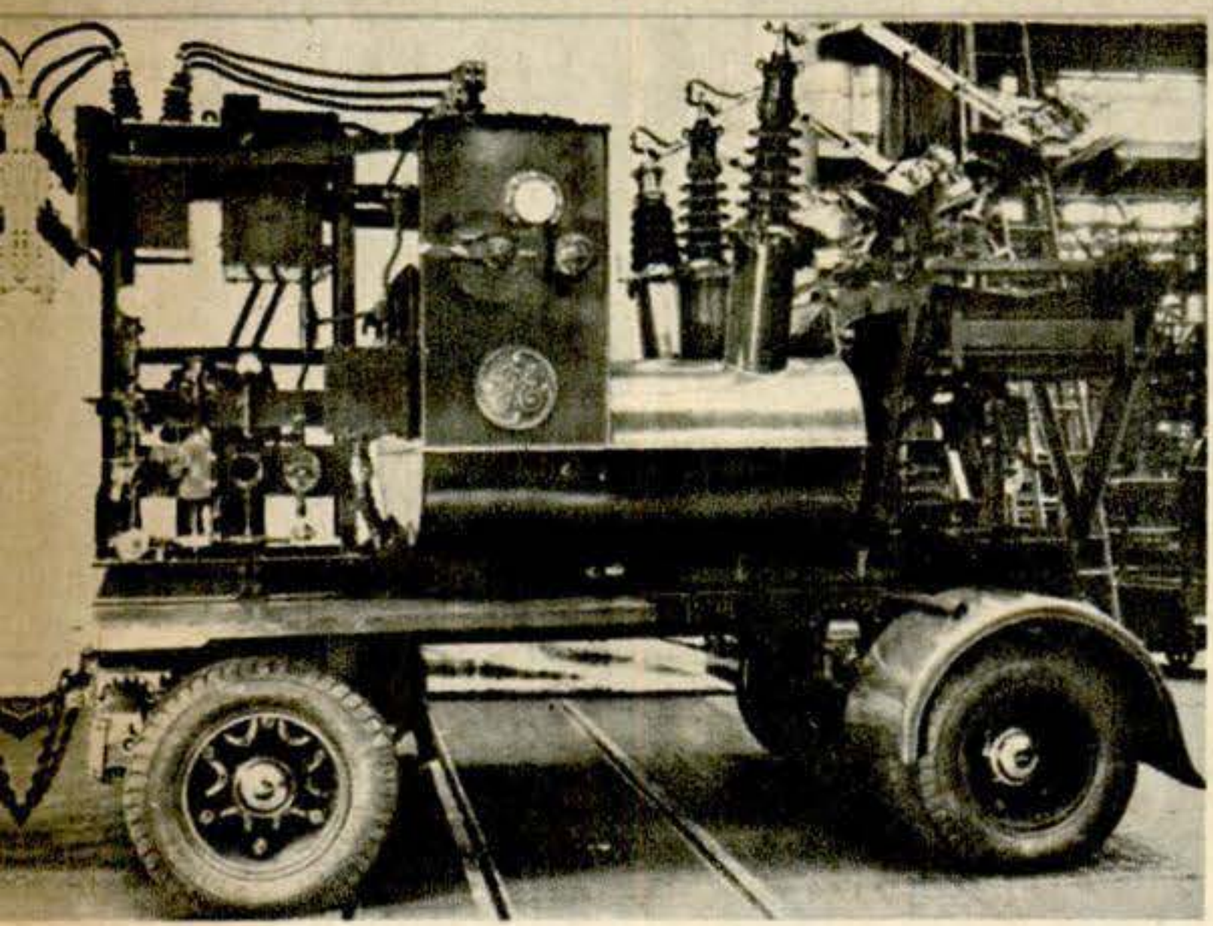




This mobile substation doesn't look much like the sleek, compact job at the top of the page. Yet mechanically they are the same, the only difference being that the newer version has been streamlined and has a better parts arrangement. From the point of appearance, the old model looks powerful, but gives no suggestion of its ability to move rapidly

BEFORE AFTER

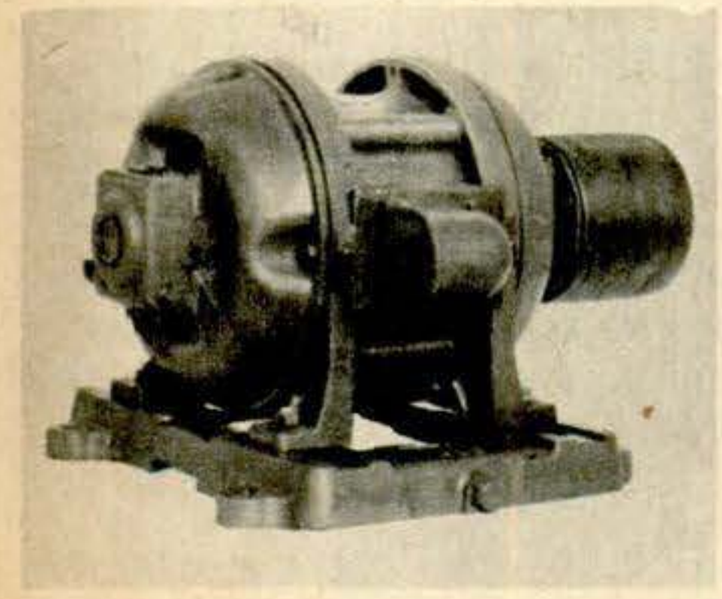
New Faces for Postwar Industrial Equipment

HEAVY electrical apparatus doesn't have to be ugly. In fact, it *can't* be, if it expects to find a market against the keen competition of the postwar world. Makers of durable goods, like the manufacturers of automobiles and home furnishings, now realize that their products must be easy to look at as well as efficient and economical in operation.

One of the leaders in this trend is General Electric. Under the guidance of Ray Patten, nationally known industrial designer, GE engineers are beautifying such pro-

In restyling the common electric motor, one of the first pieces of electrical equipment to be revamped, General Electric evolved a pattern now followed by most motor manufacturers. The new trimlined Tri-Clad motors have a one-piece cast-iron frame and a cast-iron end shield which protect the vital parts from hard blows, falling objects, and liquids

BEFORE



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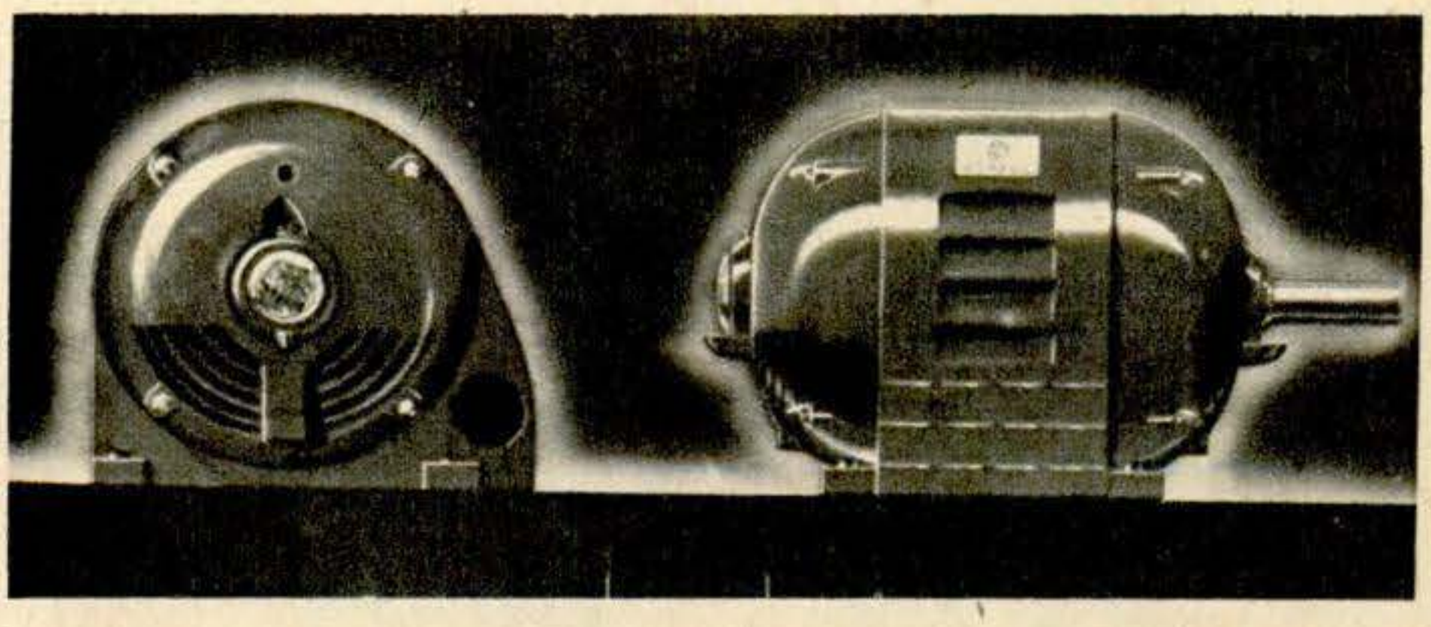

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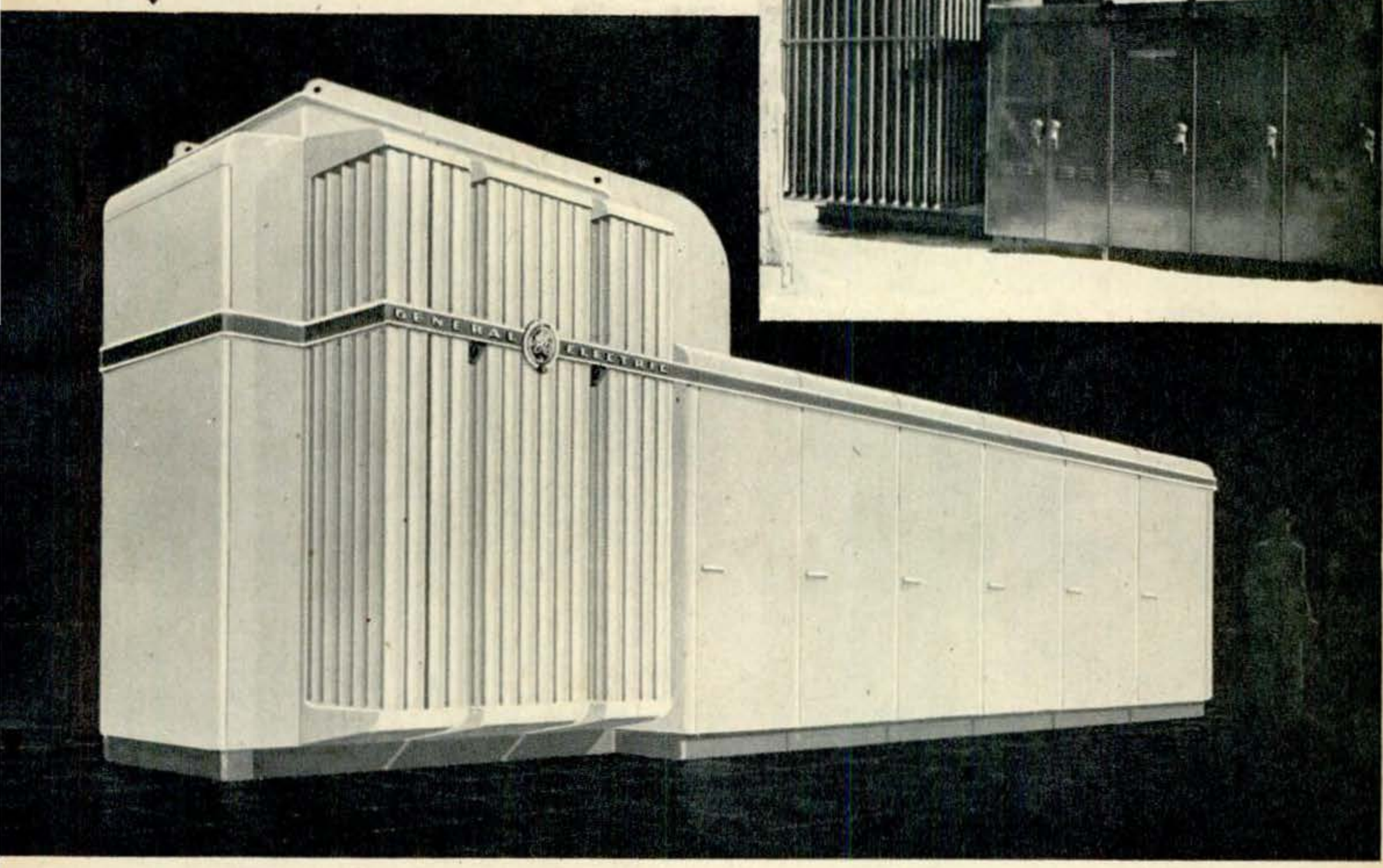
In tidying up this unit substation, GE's designers, by bringing together the transformer and switchgear to reduce the over-all length of the unit, have achieved an unusual degree of unity and compactness. In place of the bewildering maze of overhead wires in old unit, new model provides for underground connections

AFTER **BEFORE**

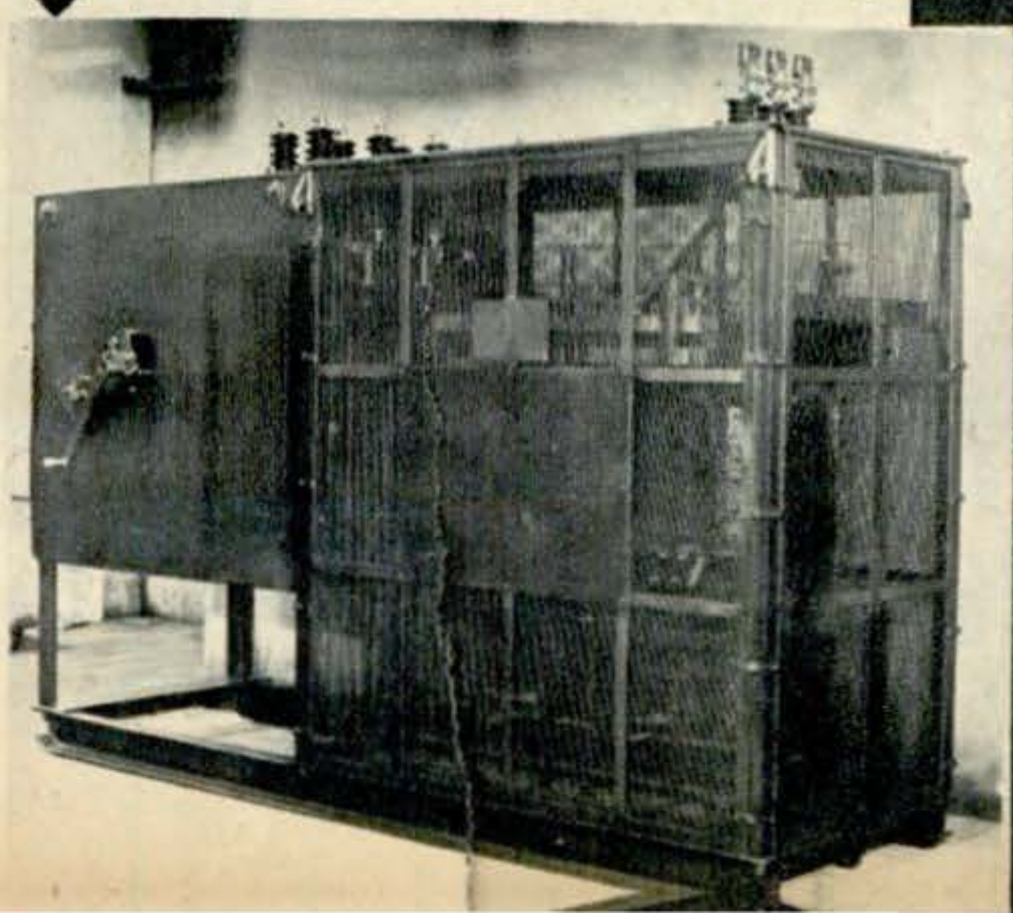


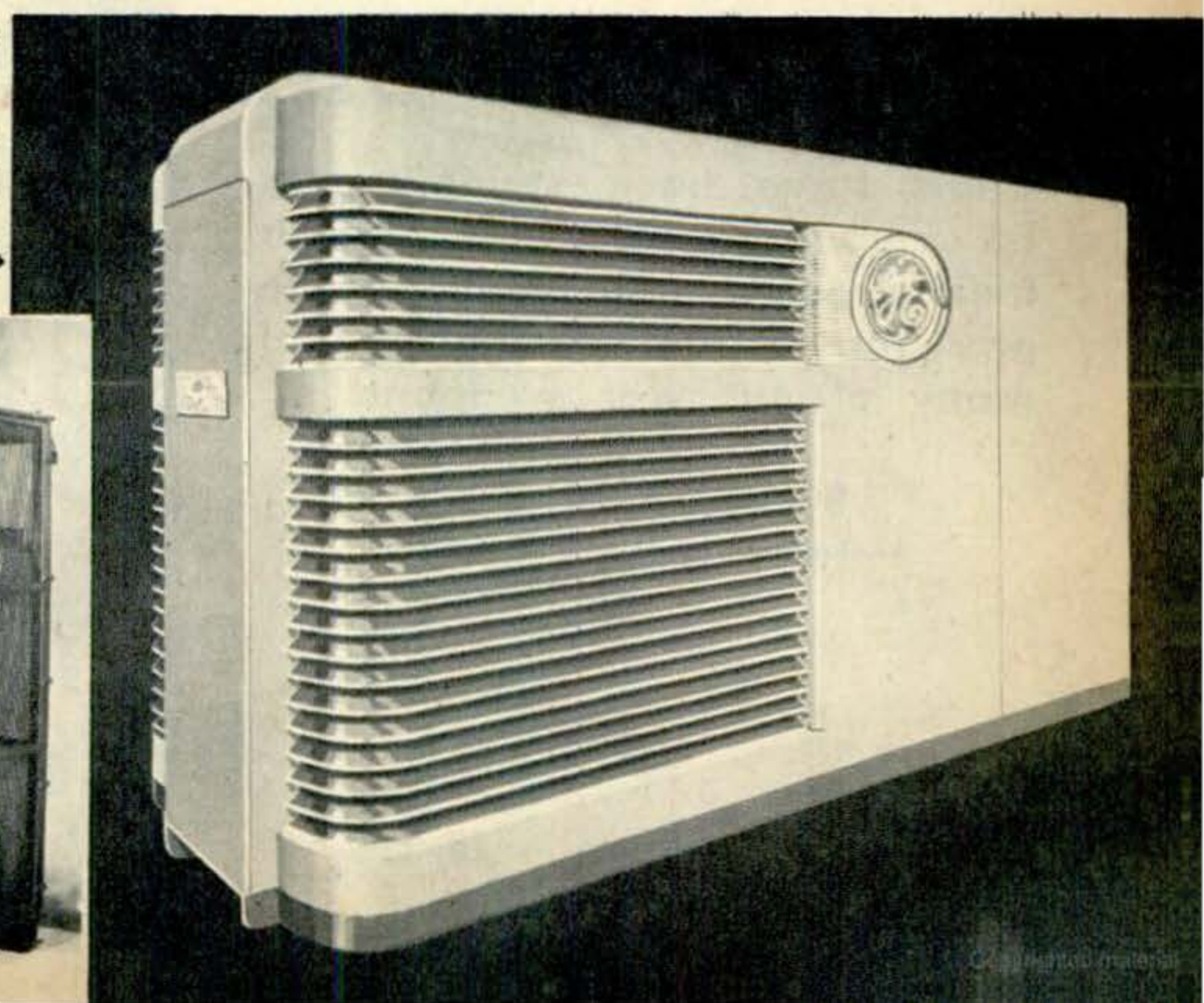
saic items as electric motors, substations, locomotives, and transformers.

This new beauty isn't just skin deep, either. In adding eye appeal to General Electric industrial equipment, Patten and his designers have revamped many products so that they weigh less, occupy less space, have a better arrangement of parts, require less materials, are easier to operate, are better protected, and in many cases offer better protection to the workers who will operate them.

While acquiring a prettier face, this dry-type transformer has also got rid of some excess weight. And, requiring fewer materials, it can now be sold at a lower price. Another important asset is that it provides much more safety

BEFORE **AFTER**





CLUSTER GEARS. When two or more gears are made in one piece, the combination is called a cluster gear. The one in the center, above, has two gears: the larger of one-inch diameter and 48 pitch; the smaller of half-inch diameter, 32 pitch

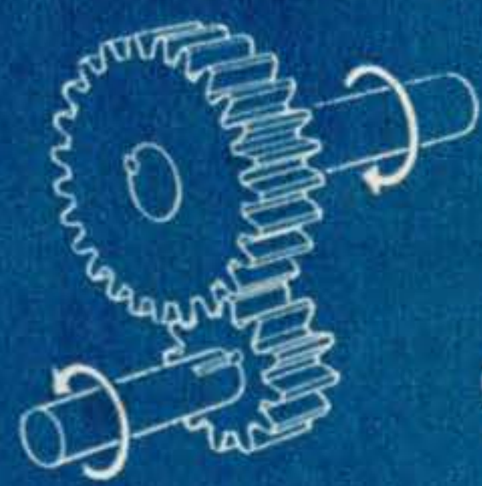
WHEELS That Can't Slip

Gears have been serving man for centuries. Now they reach their greatest refinement in the precision instruments that control many of our war weapons.

By VOLTA TORREY

Photographs by ROBERT F. SMITH

GEARS ARE DESIGNED TO DO A VARIETY OF JOBS

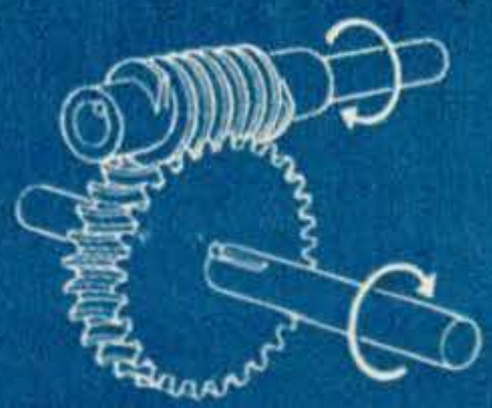


SPUR gears have teeth cut parallel to the axis of the shaft. They are commonly used for connecting two parallel shafts

STRAIGHT BEVEL

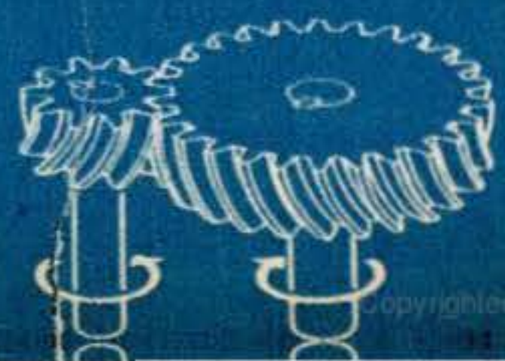
BEVEL gears, used to transmit motion between shafts at right angles to each other, have teeth cut in a surface at an angle to the axis of the shaft

HELICAL BEVEL



WORM gears use a screw-type gear in combination with a spur or worm wheel

HELICAL gears, employing teeth cut on a spiral angle, give smooth contact when they roll together



A HAIR perhaps," wrote the great mathematician and poet, Omar Khayyam, "divides the False and True." Less than a hair, in the gearing of an automatic pilot, bombsight or gun director, decides the twentieth-century soldier's fate.

Inside a single, modern, mechanical anti-aircraft gun director there are nearly 700 gears. Many of them must be within one four-thousandth of an inch of the engineer's specifications, if the gun aimed by this mechanical brain is to hit a diving, darting attacker. A four-thousandth of an inch is only one twelfth the average diameter of a human hair.

The marksmanship of an American fighting man is determined nowadays by the precision with which such gears have been made for him far behind the lines. And the mass production of extremely precise gears is a wartime achievement that marks another significant step in the evolution of revolving wheels.

The Egyptians put wooden pegs in the rims of crude wheels, so that an ox walking in a circle could raise water from a well. The transmission of power from one shaft to another is still the most common function of gears. But, thanks to many improvements, gears have also become a means of transferring measured motion within instruments that solve intricate mathematical problems hundreds of times as fast as a quiz kid could do it.

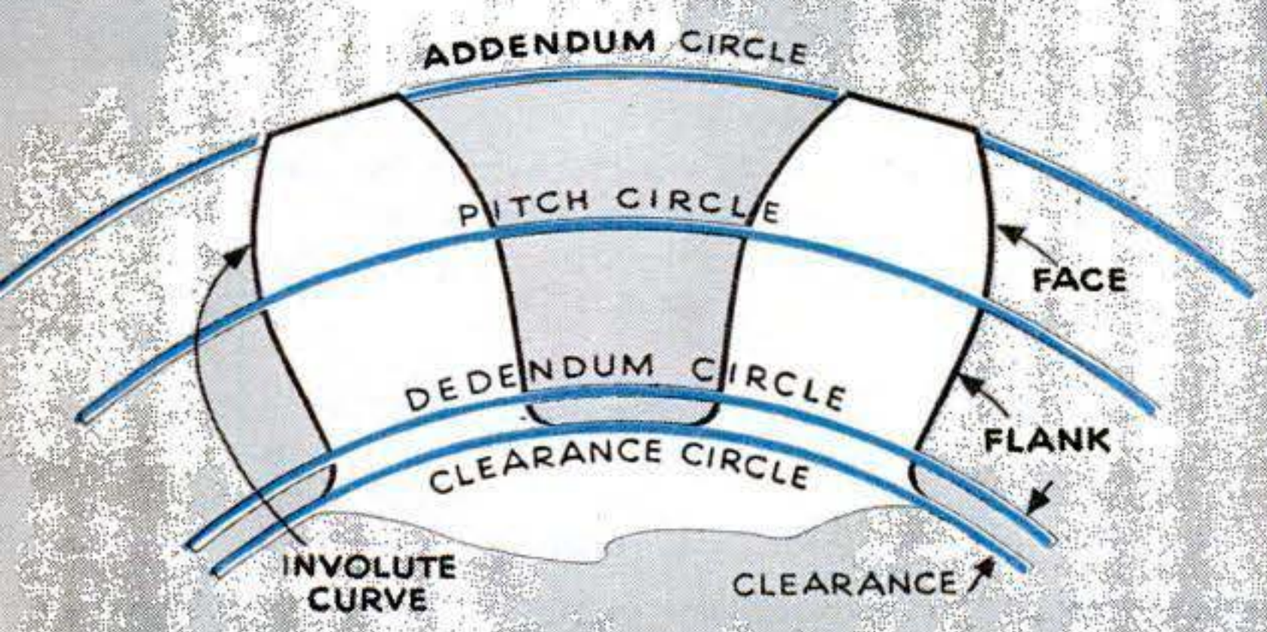
The first metal gears were made the ancient way, by setting pins in the rims of wheels. Then men learned to cast metal wheels with notched rims. Even so, if the teeth of those gears were within a thirty-second of an inch of the proper places, the makers congratulated themselves.

Some seventeenth-century mathematicians pointed out that gears could be made more efficient by curving the teeth geometrically. This was done at first by hand, and the precision of the gear depended on the workman's skill. Less than a century ago, machines were invented to cut curved gear teeth. Now those machines have been so perfected that they produce almost perfect gears.

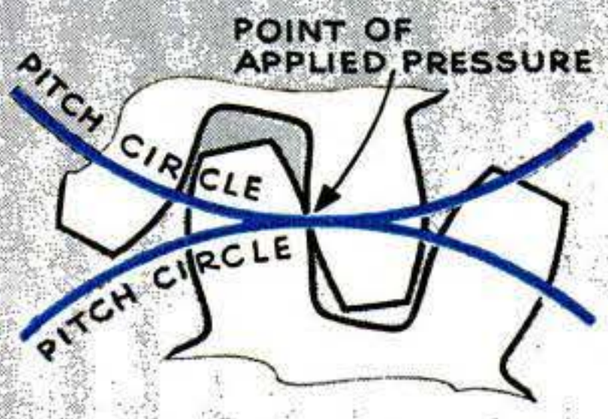
The teeth of these machine-made gears are as uniform as the balls for ball bearings. Differences in the spaces between the teeth are infinitesimal. Every tooth fits every niche in another gear as though each tooth and niche had been hand-tailored for each other.

Although often no larger than the gears in a watch, the gears in an intricate navigation instrument or gun director must mesh even better. Watch gears always turn in one direction at a steady speed. But the gears in the computing machines used to guide mighty weapons must alternately spin and creep, sometimes clockwise and sometimes counterclockwise. Hence, the least bit of backlash, or slackness in the gearing,

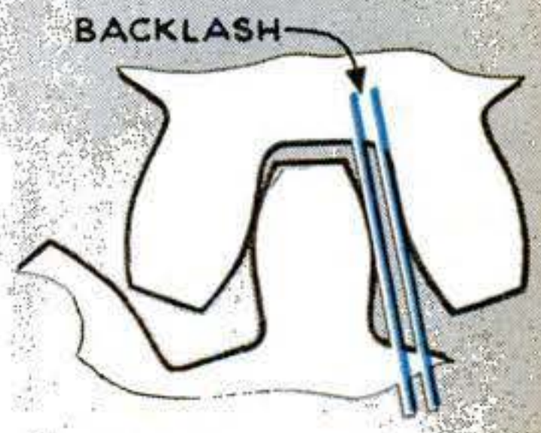
HERE ARE SOME TERMS USED IN DESCRIBING GEARS



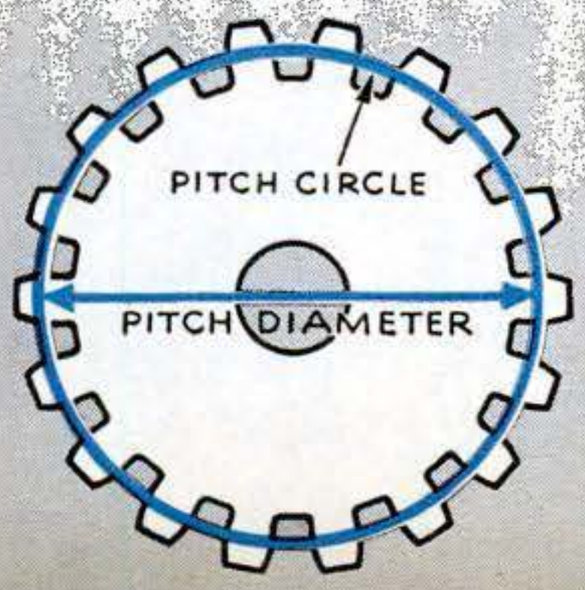
ANATOMY OF A GEAR. These four circles fix the design of a gear. Engineers like to visualize a pair of meshing gears as two cylinders with projections and depressions that interlock, the pitch circles representing their theoretical surfaces



PITCH CIRCLE intersects the points of applied pressure, where there is a pure rolling action between mating teeth of a pair of gears

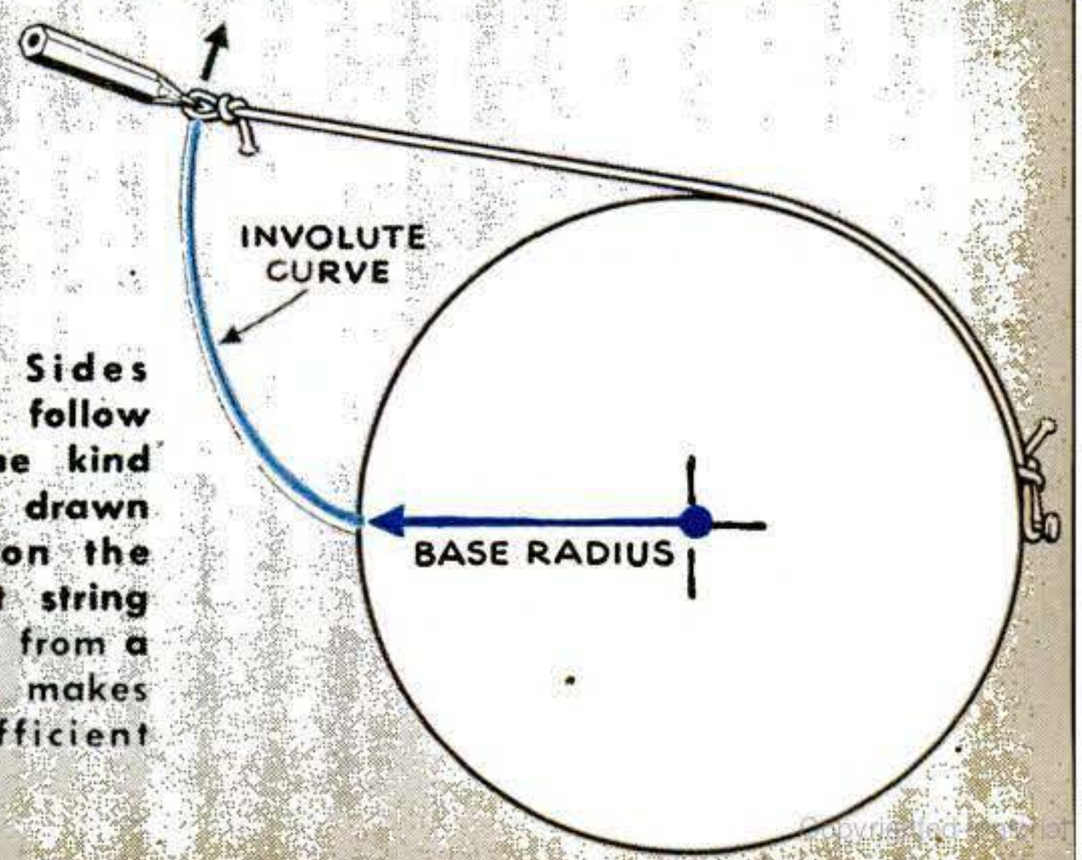


BACKLASH is play or slackness due to inaccurate fitting of teeth. Not a good thing in precision instruments



DIAMETRAL pitch of a gear is the number of teeth it has for every inch of pitch diameter. As shown at left, pitch diameter is the diameter of the pitch circle

INVOLUTE. Sides of gear teeth follow a curve of the kind that would be drawn by a pencil on the end of a taut string being unwound from a spool. Curving makes gears more efficient



would lessen the accuracy of the calculations made by the mechanism.

There is so little backlash in the gears now being made in wholesale quantities for such instruments that it cannot be seen by the human eye or felt by the most sensitive of fingers. But it can be detected and measured by extremely sensitive instruments; by repeatedly testing each gear with these instruments, this looseness is held to a minimum.

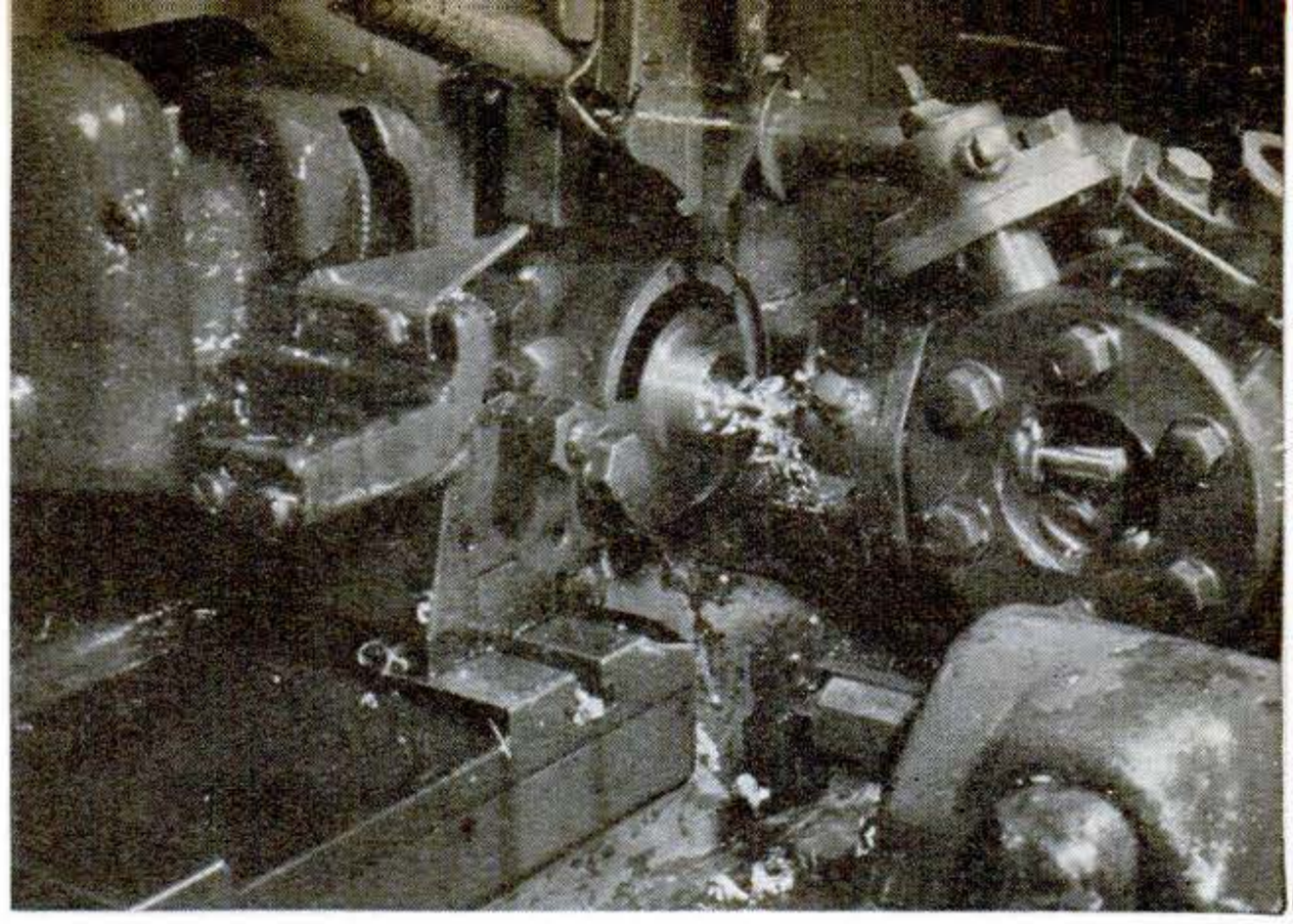
Assume, for a moment, that you had an endless row of these modern gears, each of which was four inches in diameter and had 192 teeth. If the gears were correctly mounted on separate shafts, and you had someone hold the first gear stationary, you would have to go down the line to the 50,264th gear before the accumulated backlash would permit you to revolve one. You would then be more than three miles from your starting point.

Wheels with such excellent teeth are called fine-pitch gears. Their function is to impart dial or indexing motion from one shaft to another. In many modern instruments, this is done to govern the movements of the fine-pitch gears' brawny brothers, the power-transmission gears. Fine-pitch gears, consequently, are often literally the bosses of cruder but heavier gears.

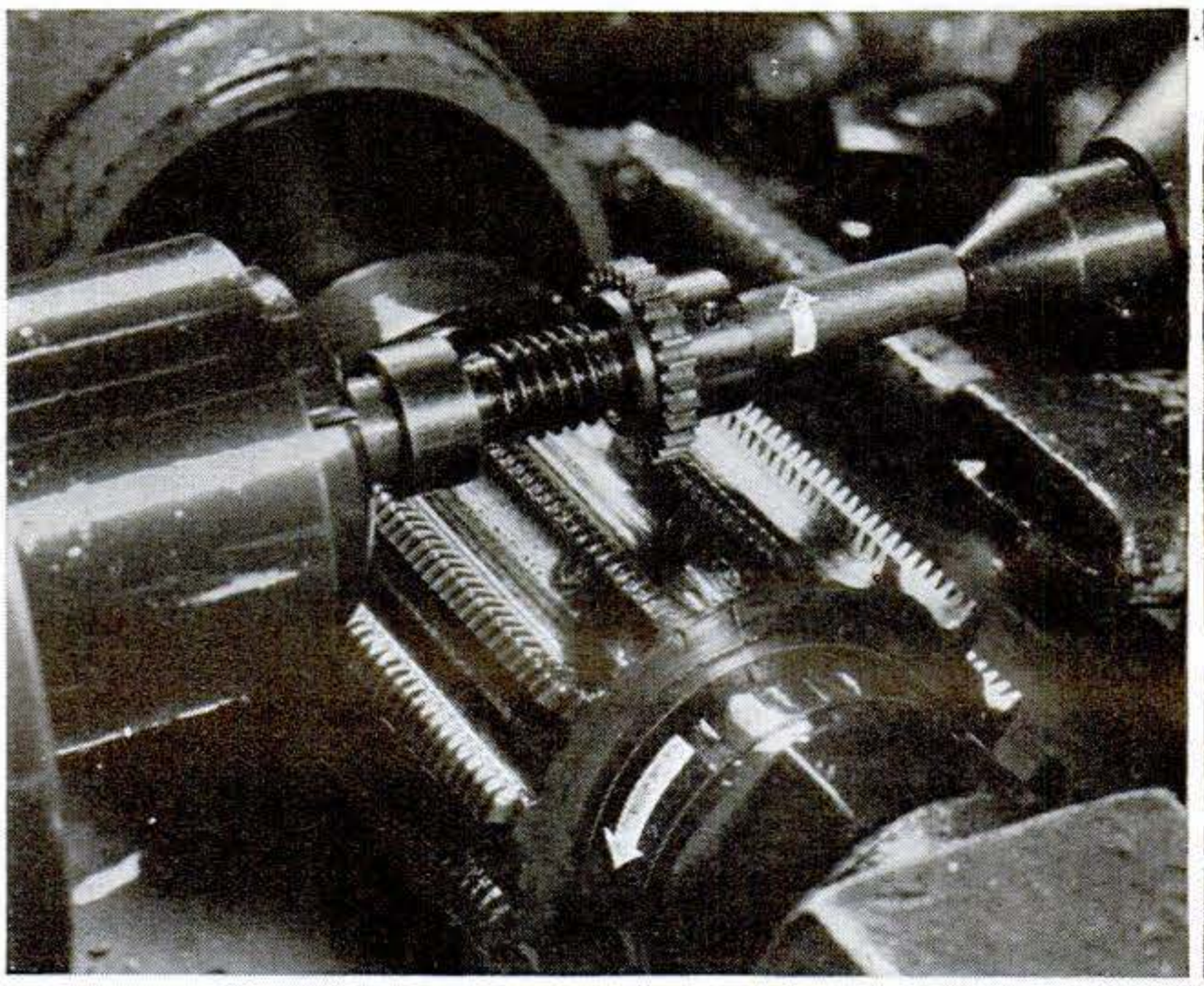
Although each tooth of a fine-pitch gear is really a cam, it must be almost exactly like every other tooth. Suppose, now, that you had two of these gears, each containing 50 teeth, making three revolutions a second. There would then be 9,000 engagements and disengagements per minute between teeth, and the slightest variation in teeth would cause a fluctuation in the motion transmitted from the first shaft to the second shaft.

The sides of every tooth are so curved that these engagements and disengagements are made smoothly at any speed. The curve is usually an involute curve, which means that it is the kind of curve that would be traced by a pencil on the end of a taut string being unwound from a spool. Although the teeth of a tiny, fine-pitch gear often look perfectly straight, each side of each tooth curves this way.

Nevertheless, the delicate carving necessary to shape each of the many teeth of these gears properly is done in a few minutes by modern gear-cutting machines. These masterpieces of the machine-tool maker's science, moreover, can be operated by women who cannot

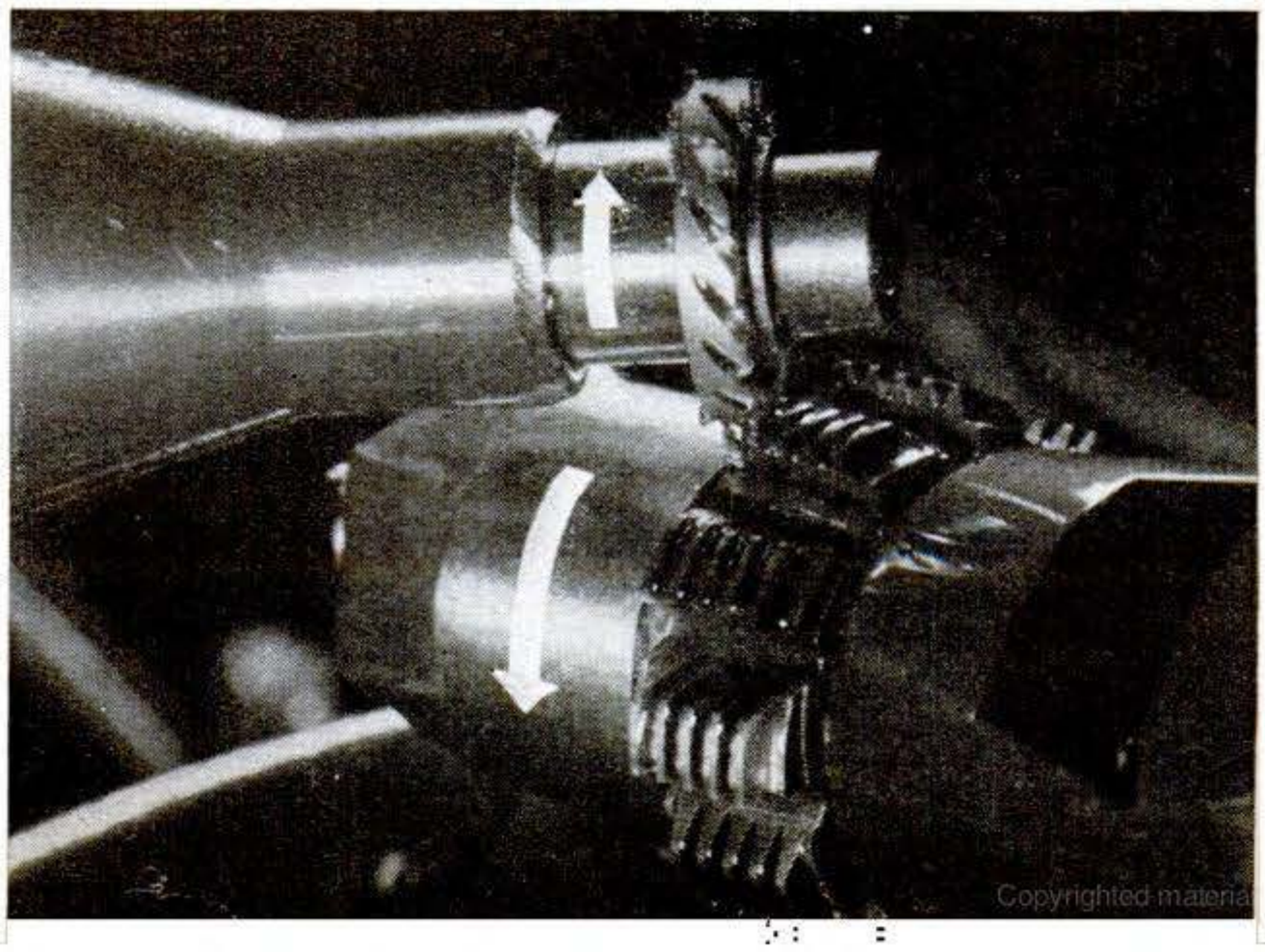


BLANKS for gears, cut from a solid rod of metal, are bored, reamed, and formed to size on this machine. Photo shows drilling; note boring tool poised ready for next operation. The sequence is controlled by cams



This is the completed gear made by the hobbing method. The machine shown in this picture and the two at the top of the opposite page is a Barber-Coleman No. 3. All arrows on pictures show the directions of rotation

HELICAL SPUR GEAR is cut by another hobbing operation. In this case, the teeth of the gear are cut at an angle by holding the blank with its axis at an angle to that of the hob rotating underneath it



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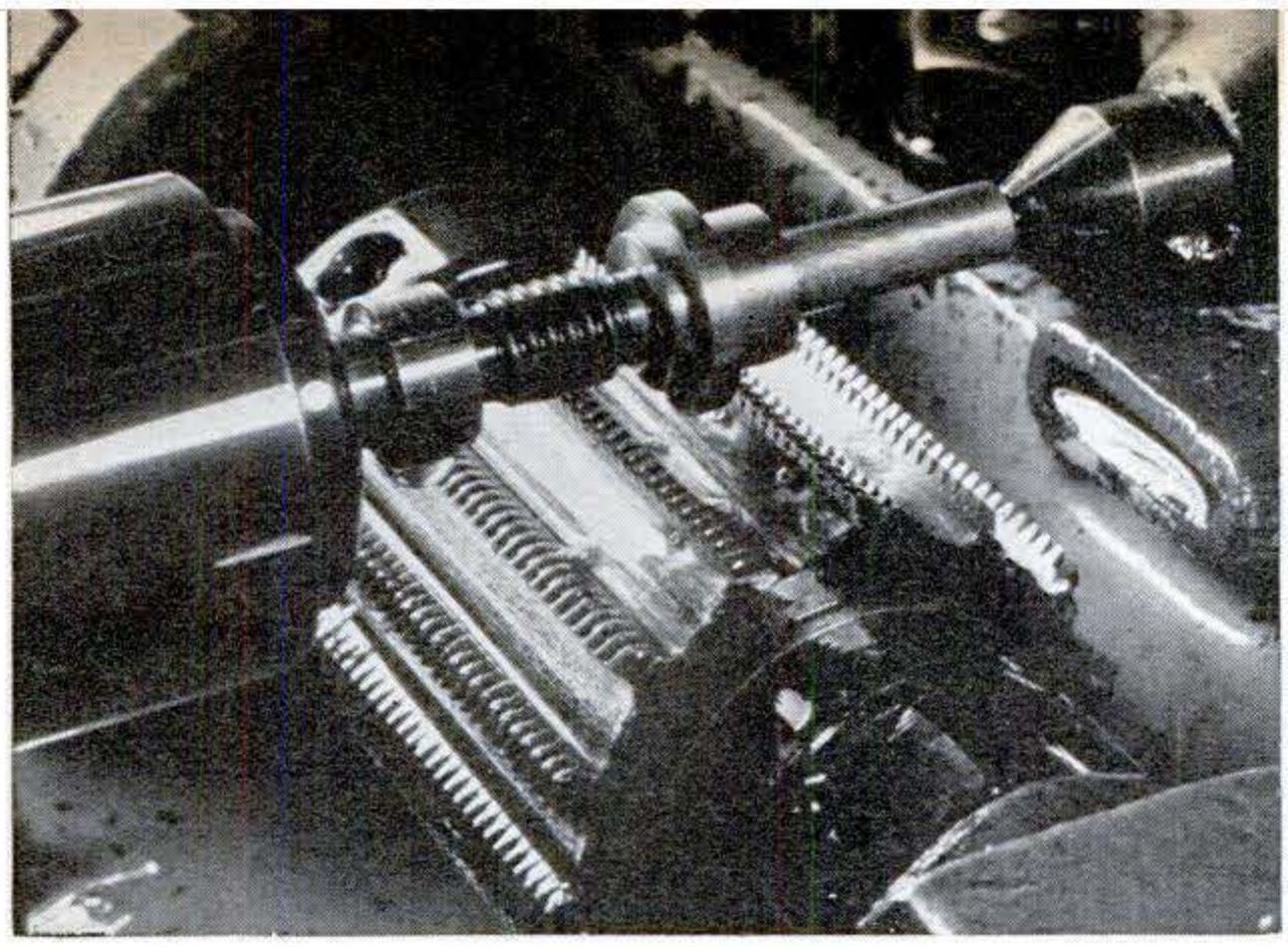
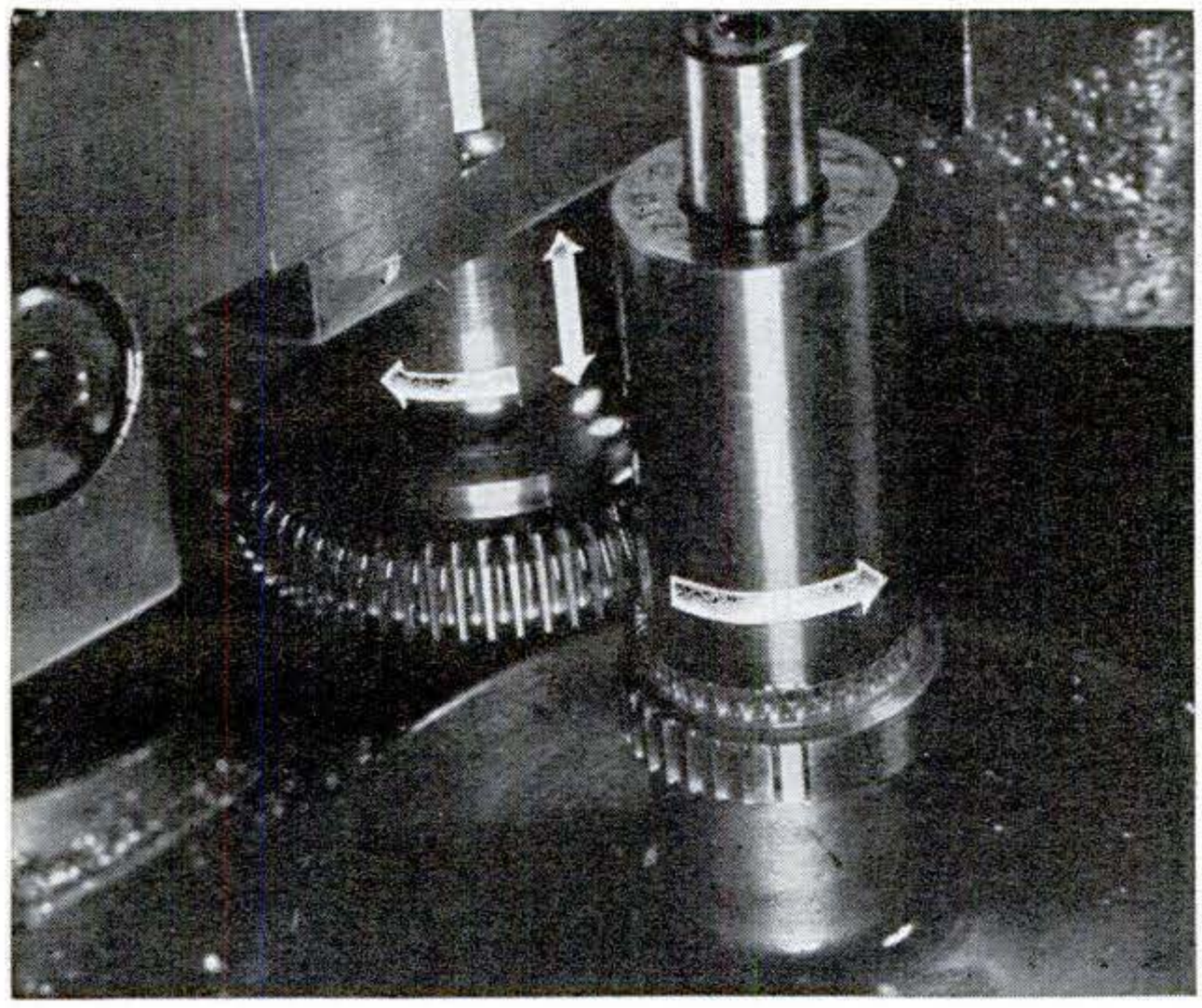
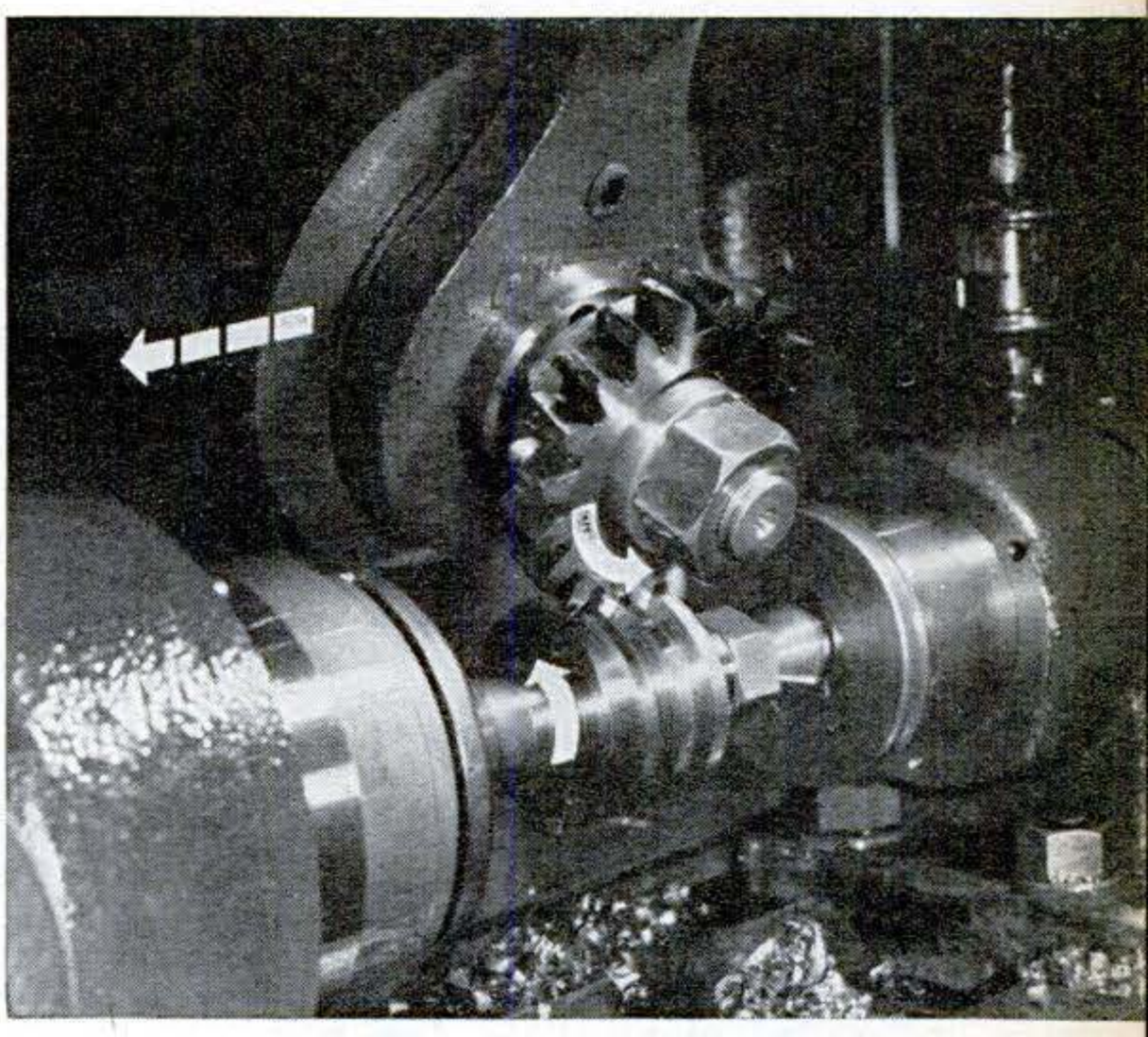


HOBBING is one method of cutting teeth in the rim of a blank. Here the blank is seen mounted above the hob, which is a cylinder bearing cutting blades in the form of a worm. Hob and blank revolve simultaneously

Cutting takes place in a stream of oil. The relative rotating speeds of the hob and blank are determined by gearing. By changing this gearing, the same machine can be used for cutting a wide variety of gears



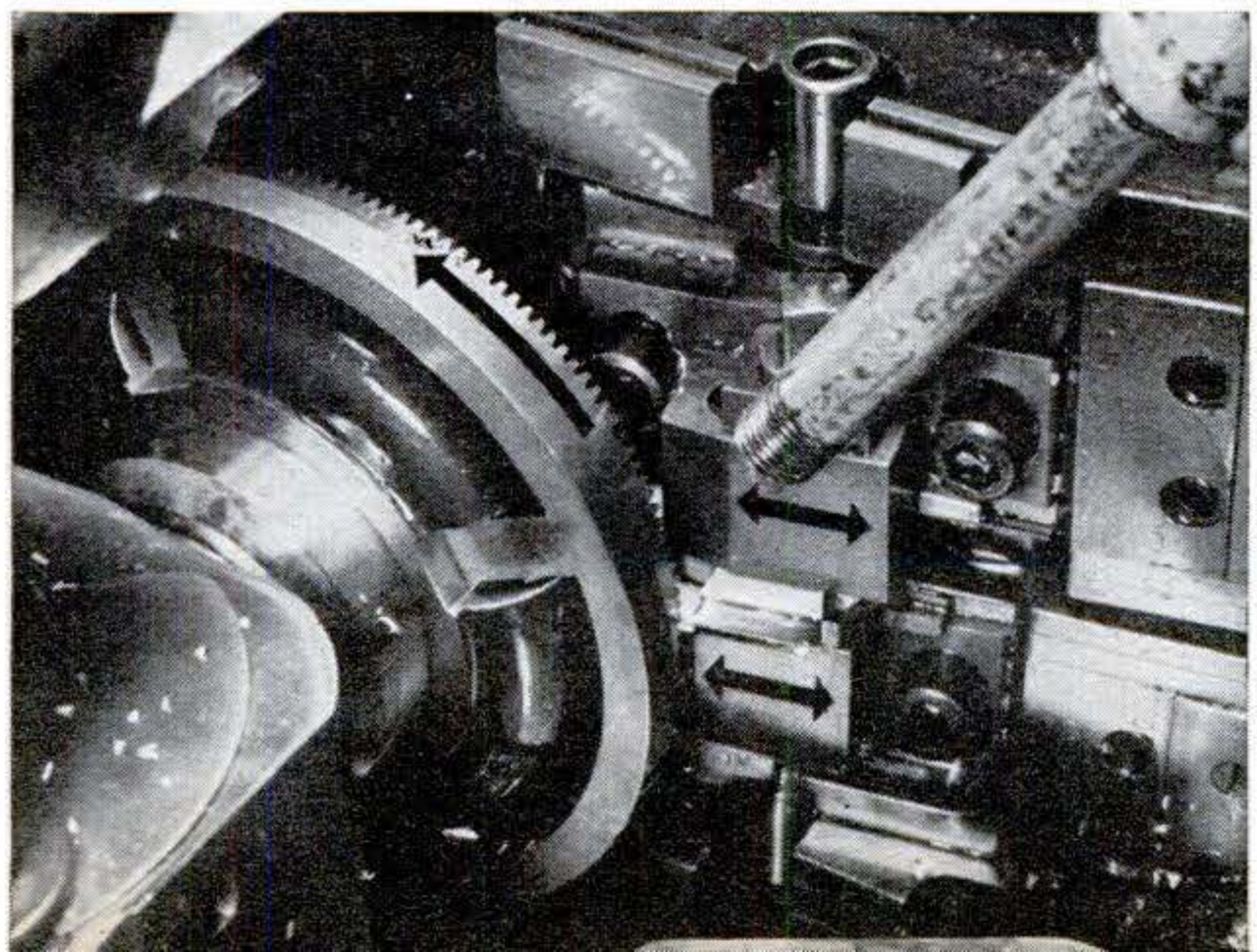


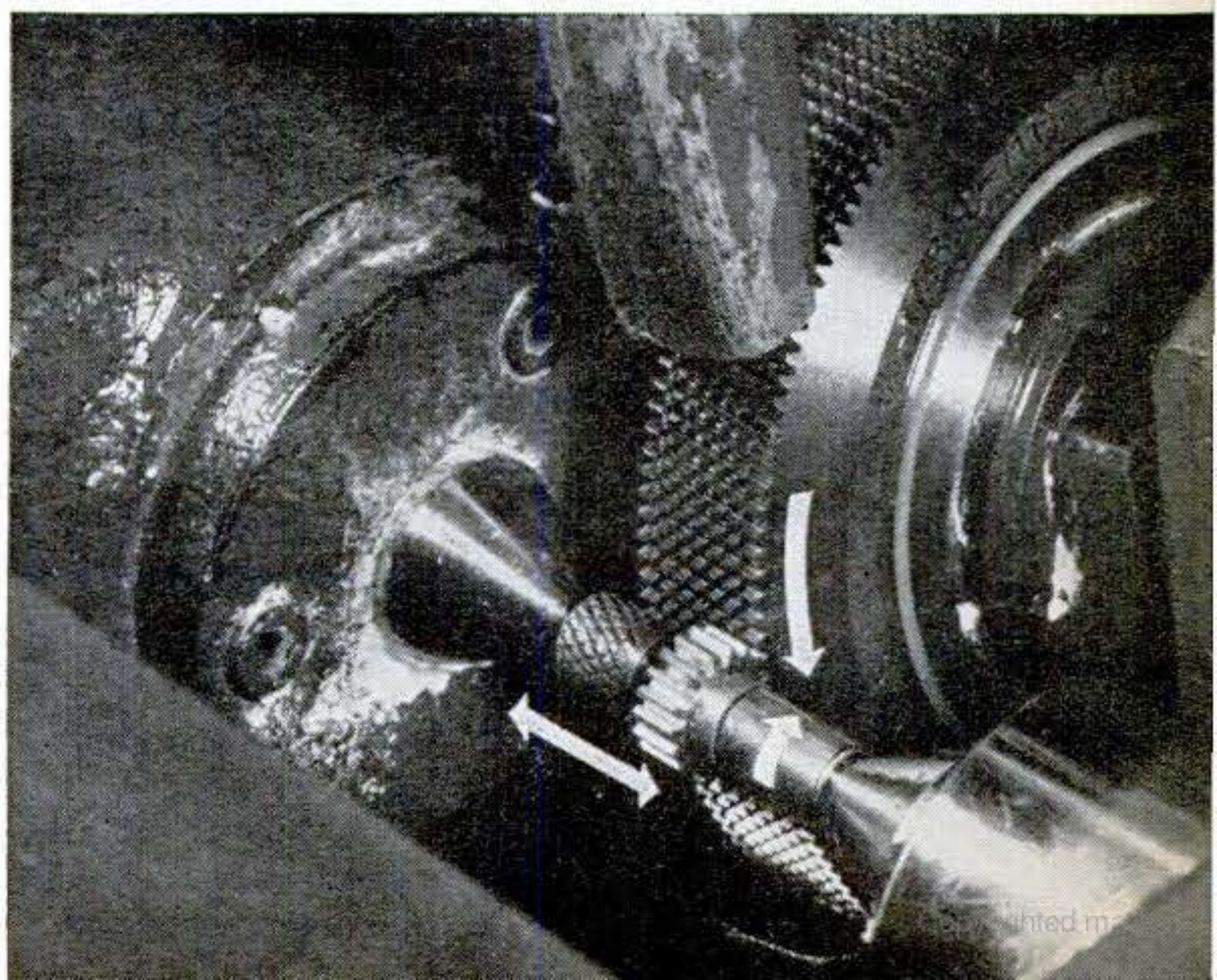
FELLOWS process shapes gear teeth by planing action. The cutter (at left) has teeth resembling those desired in the blank. Rotating with the blank, cutter feeds slowly into the work until all the teeth are cut

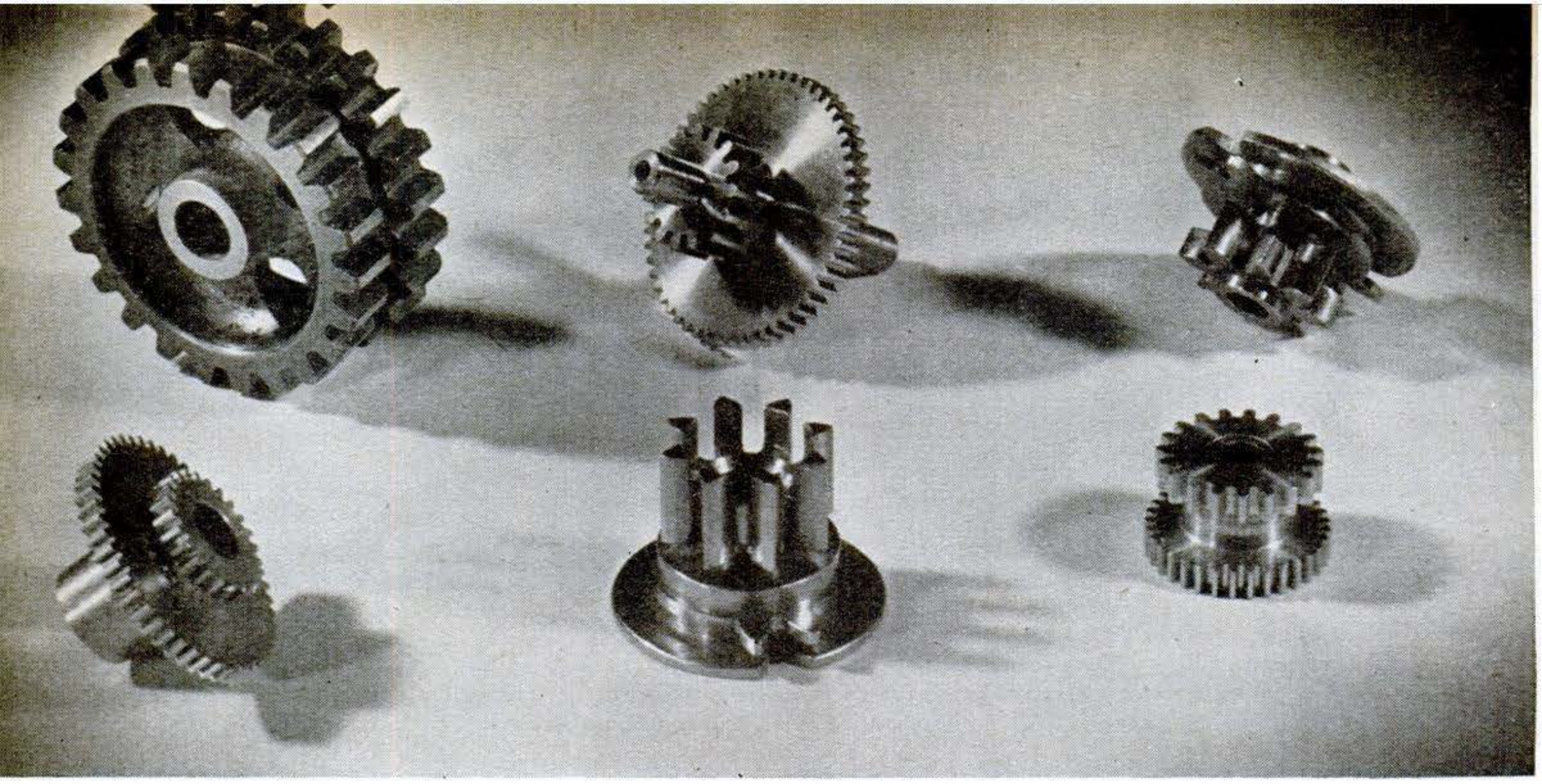
WORM CUTTER. Here the thread of a worm gear is being shaped. The gearlike cutter bites into the cylindrical blank while both are rotated, producing the screwlike thread that characterizes the worm gear

GLEASON machine cuts straight bevel gears by the reciprocating action of little cutters resembling safety-razor blades. In the picture below, these are seen immediately below the end of the oil nozzle

FINISHING of gears cut on a hobber or shaper is done in this shaving machine. The teeth of the cutter (the large wheel) usually are set in a helix to the axis in order to assist the cutting or shaving action







MORE CLUSTER GEARS (see page 120). These six examples show how various kinds of teeth can be cut in a single piece of metal. Some have teeth of odd design to meet special requirements. Cluster gears simplify assembly and make it possible to obtain many different speeds from a compact gearing unit

even cut fudge into uniform pieces by hand. Scores of persons with comparatively little training have operated these machines in war plants. And batteries of these modern cutting machines have enabled the Sperry Gyroscope Co., the Ford Motor Co., and other firms to turn out tremendous quantities of fine-pitch gears for precision instruments.

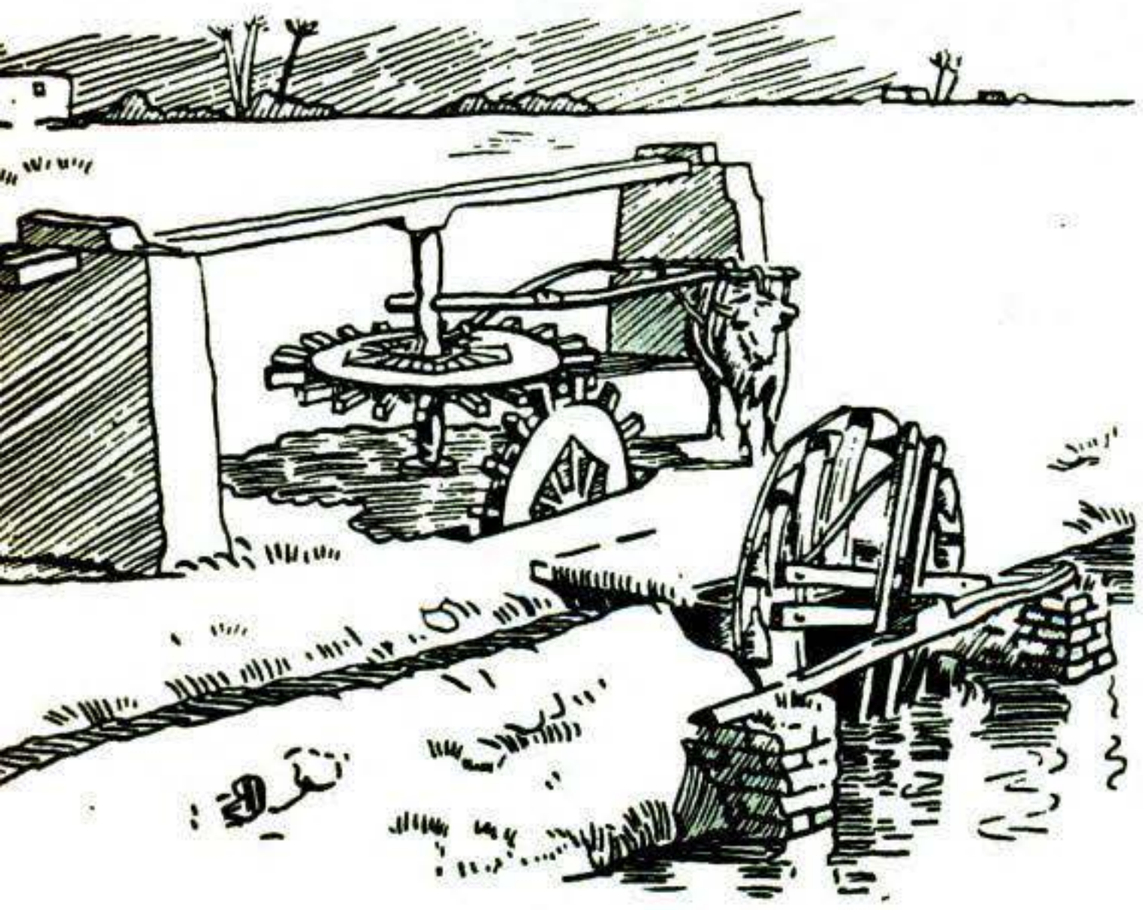
Among the fine-pitch gears in mass production there are many different types, such as spur, helical, bevel, and worm gears, and combinations of various types. *Spur* gears are those with teeth cut parallel to the axis. These gears are used to connect parallel shafts. *Helical* gears are those with spiral or curving teeth rather than straight teeth. This is a means of facilitating contact between teeth when two gears are rolled together, thus assuring smoother operation. The teeth of a spur gear may be either straight or helical. The teeth of a *bevel* gear, which is one with teeth placed at an angle to the axis of the wheel, may be either straight or spiral. *Worm* gears have teeth like the thread of a screw. Bevel and worm gears are used to transmit motion between shafts that are not parallel.

The blank disks from which these gears are made are turned out by engine lathes, turret lathes, and screw machines. One of these machines may automatically drill a hole in a stainless-steel rod, trim it the proper amount, and cut off the kind of wheel that is needed to make a gear. Without pausing, the machine may then pull the rod forward and proceed to turn out another blank wheel. Cams and gears govern the operations of the blank-cutting machines. Other cams and gears, in other automatic machines, then direct the cutting of teeth in these blanks. Thus gears are used to manufacture gears.

One method of cutting gear teeth in a blank is hobbing. A hob has a series of

THE EGYPTIANS INVENTED GEARS

LIFTING water from a well or stream was probably the first job ever performed by gears. The Egyptians had a source of power in the form of oxen, but the beasts walked in a horizontal plane while the water had to be lifted vertically. The problem, therefore, was to transmit power from a vertical shaft to a horizontal one. Pharaoh's subjects solved it by putting wooden pegs in the rims of crude wheels and mounting them at right angles to each other as shown in the sketch below. Buckets on the rim of a third wheel picked up the water and dumped it into an irrigation ditch or tank as desired.



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blades in the form of a worm, and is revolved alongside the blank. The blank is rotated simultaneously so that the teeth cut in it by the hob will have the desired curvature. The relative speeds of the hob and the blank that is being cut are determined by gearing; other gearing controls the pressure of the hob against the blank. And, by changing this gearing within the hobbing machine, the same machine can be used to produce a considerable variety of gears.

Another method of making a gear out of a blank disk is the Fellows shaping process. A Fellows machine produces gear teeth by planing action. The cutter has teeth resembling those desired in the blank. As the cutter and the blank rotate at controlled speeds, the cutter hews niches out of the blank, and thus forms teeth of the proper size and shape.

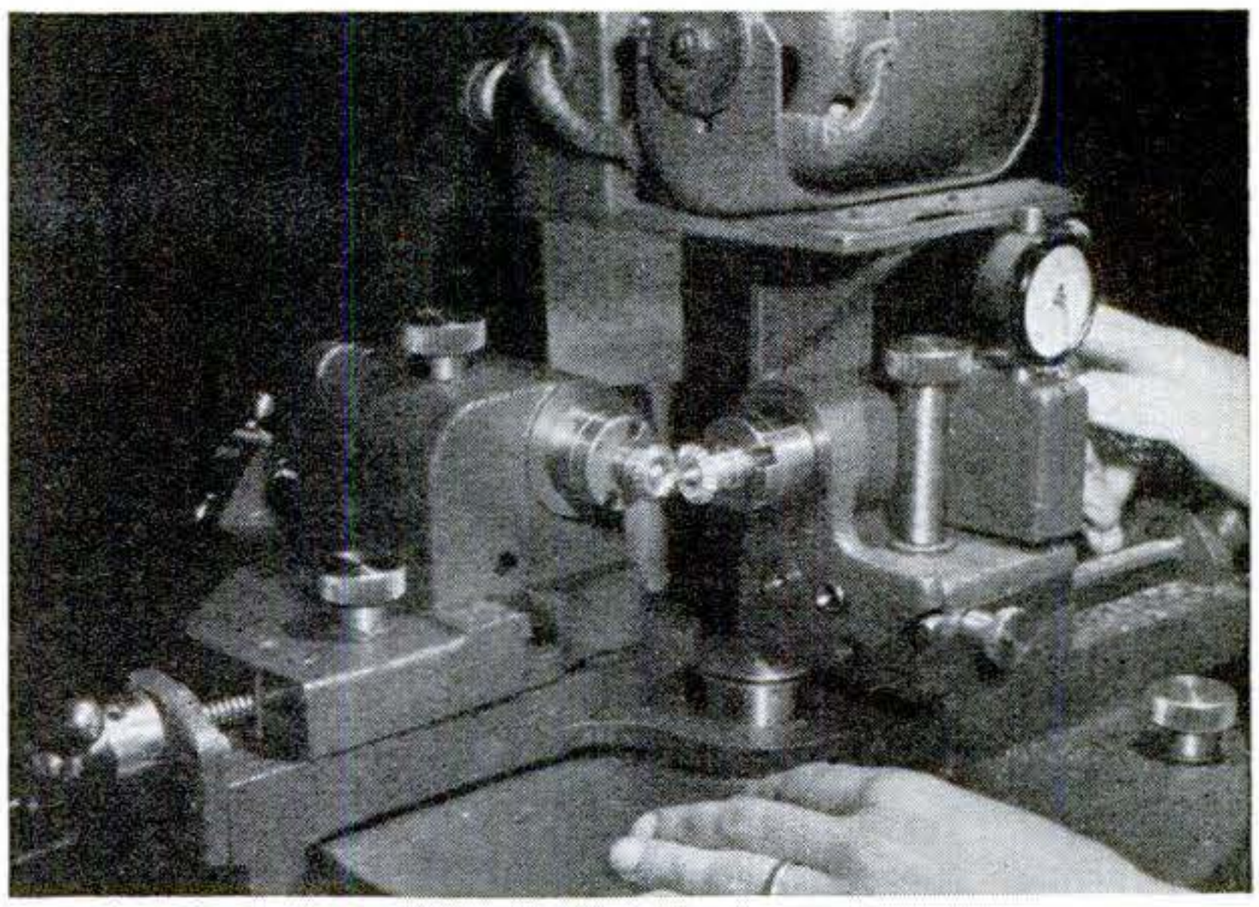
Cluster gears can be made with this machine. A cluster gear is really several gears made from a single piece of metal. There may be from two to a dozen different sets of teeth around its rim and sides. Using the same solid piece of metal for several gears simplifies assembling work, and saves precious space in compact, complex mechanisms.

A third way of cutting gears is the Gleason method, and it is used for carving bevel teeth. Straight bevel teeth are cut in a blank in the Gleason machine by the reciprocating action of little blades that look like safety-razor blades sliding to and fro. A cutterhead rolls these blades against the blank until each tooth is formed. Spiral bevel gears are cut by a rotating circular cutter, which is rolled against the blank similarly.

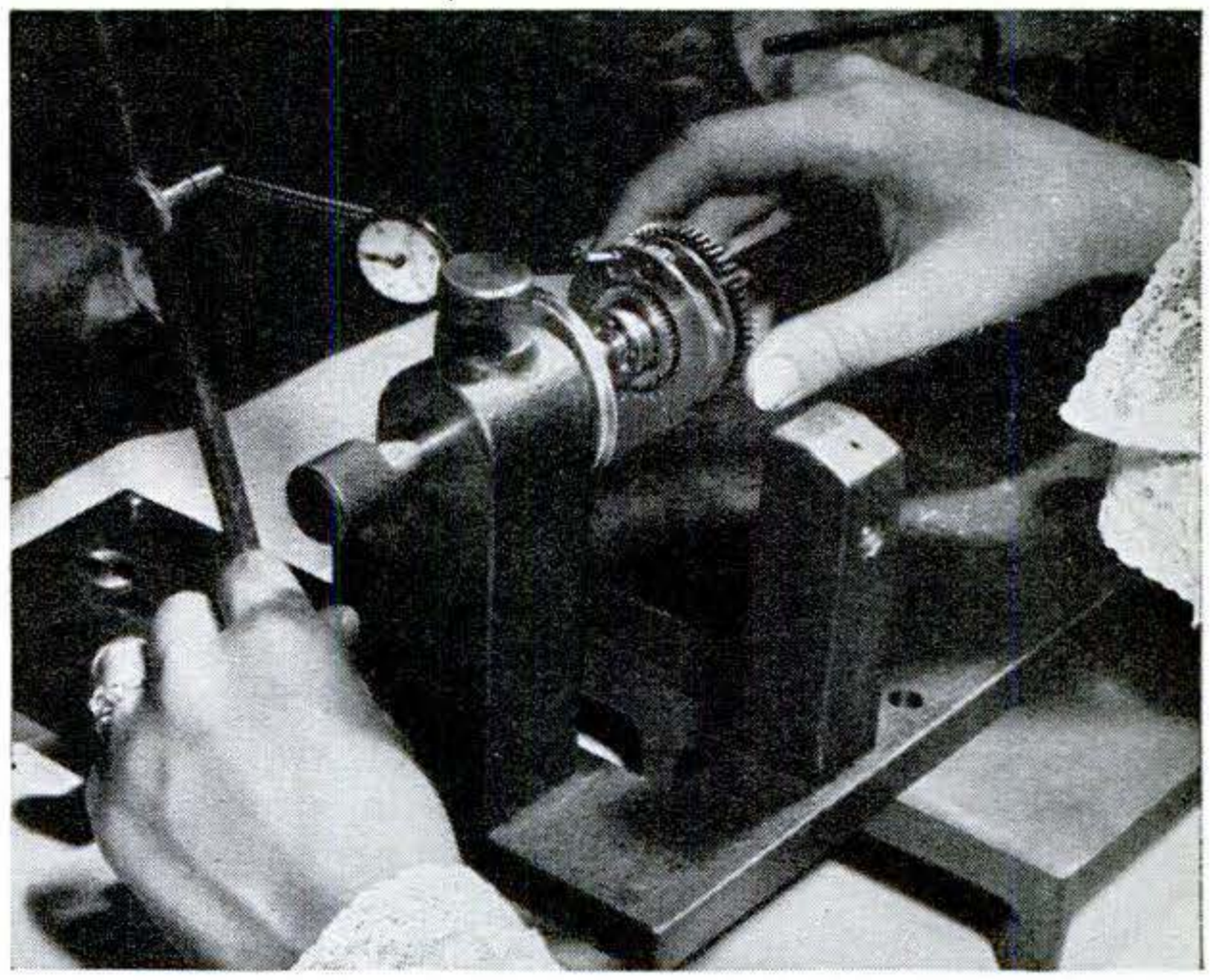
A finishing process follows the hobbing or shaping of the teeth of precision gears. This is done to eliminate small errors in the shape or spacing of the teeth. It may be done—automatically, of course—by rolling the unfinished gear against a rotary shaving cutter. Another finishing operation is burnishing. This does not correct inherent errors, but removes projections and burrs and improves the finish.

Obviously, a gear would be cut badly if a blank slipped while being spun in *(Continued on page 207)*

TESTING HIGH-PRECISION GEARS

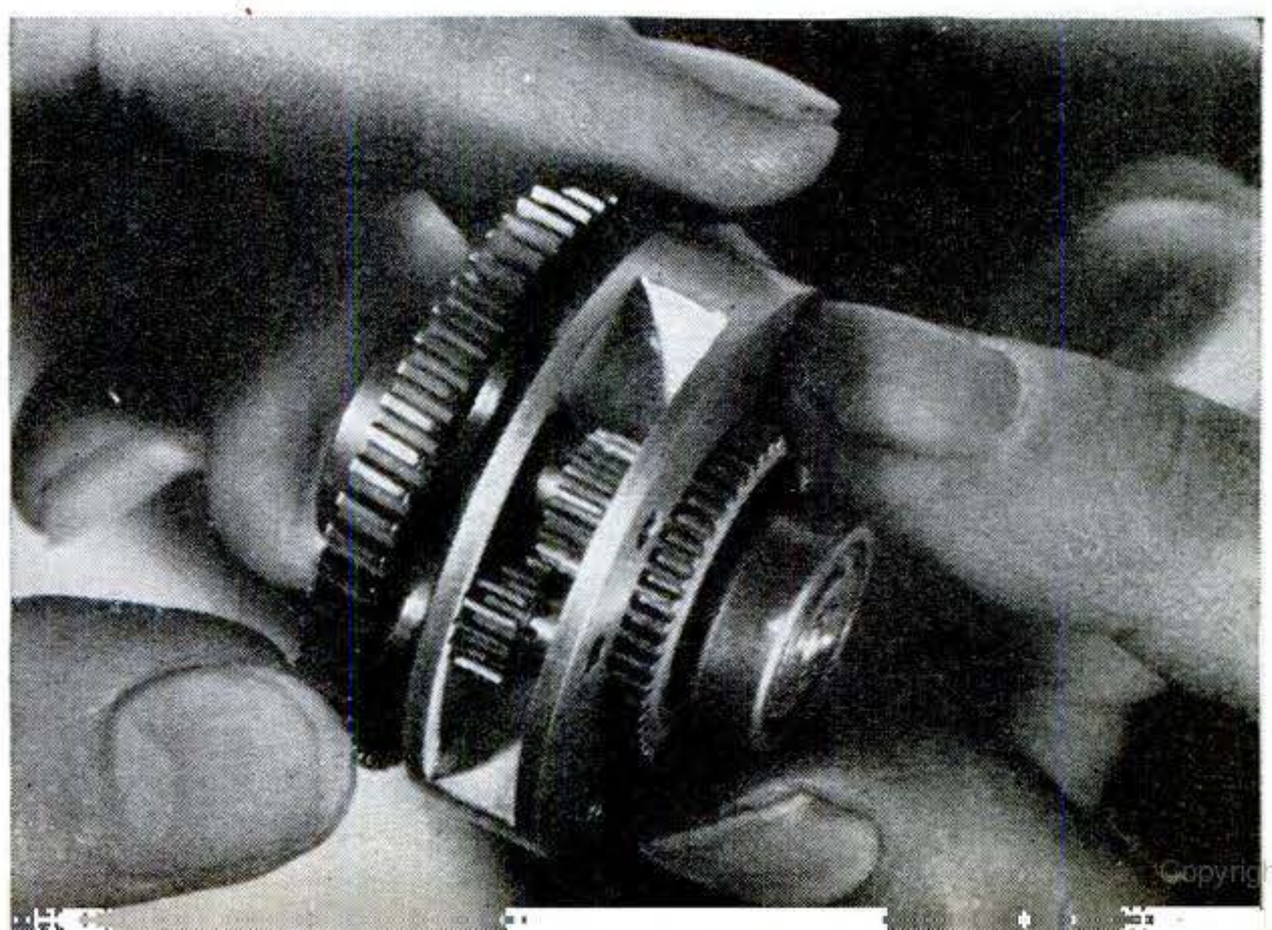


A testing machine at the Sperry Gyroscope Company's plant runs bevel gears together to determine accuracy of size and smoothness of running. Gears just off the cutting machines are run with master gears to show up possible imperfections



This sensitive apparatus detects wobble in the gears of a tiny differential containing eight fine-pitch gears. Still another test measures the backlash, or play, in the assembly

Here is the differential seen under test above. Seven teeths of the gears used in Sperry instruments are less than an inch in pitch diameter. They may have from 10 to 400 teeth



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Nineteen U. S. Inventions That Changed the World

PART II

The whole civilized world is now dependent on the American inventions described in this series by Miles Henninger, a patent lawyer of Milwaukee, Wis. His previous installment covered the grain harvester, cotton gin, sewing machine, steamboat, airplane, air brake, oil cracking, and rubber vulcanizing. Now he presents 11 more pivotal discoveries, the greater part of which are concerned with communication, either of the voice, as with the telephone, vacuum tube, and phonograph; or of ideas, as with the telegraph, typewriter, linotype, and motion-picture projector.

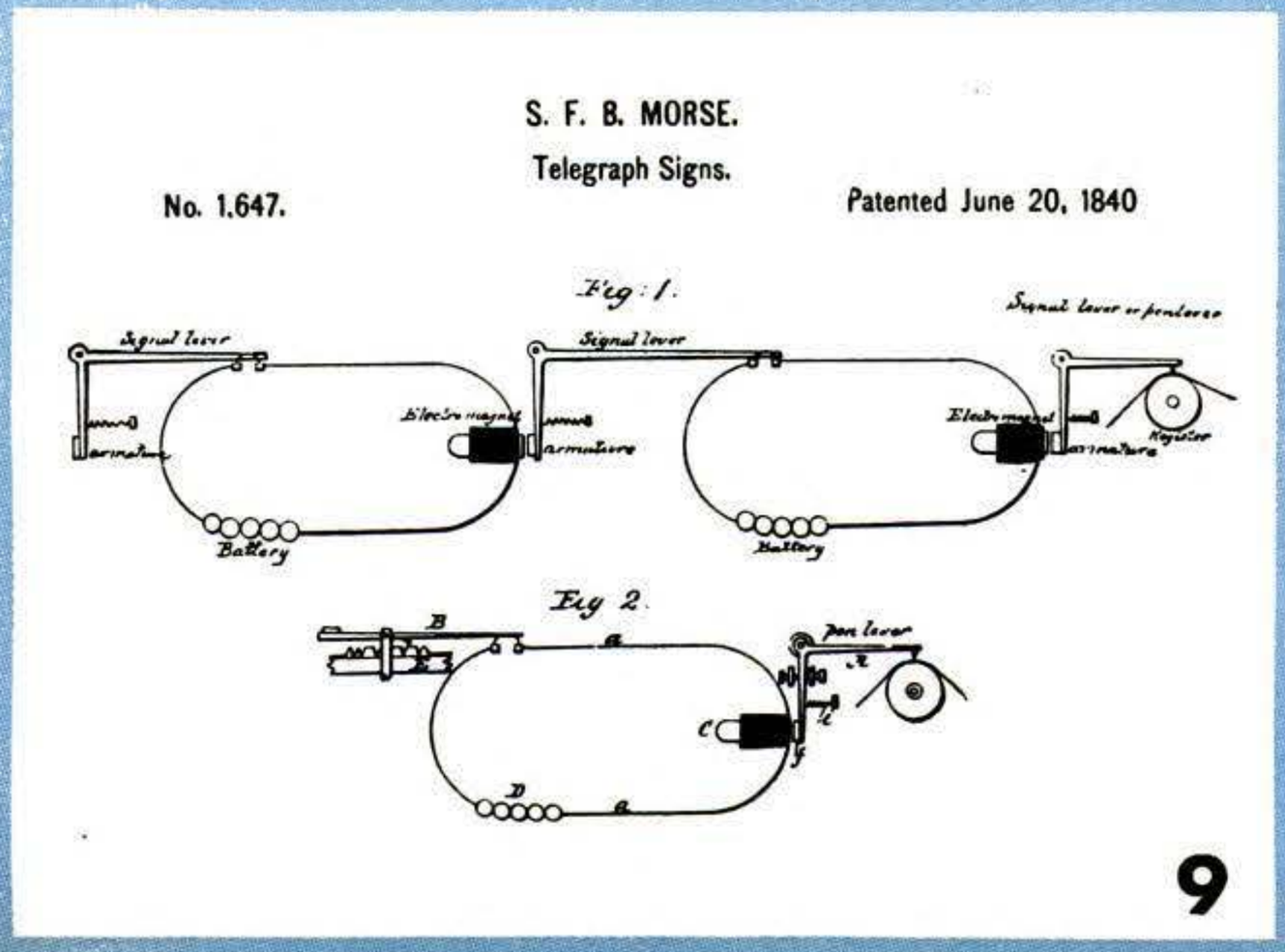
9. THE TELEGRAPH 1840

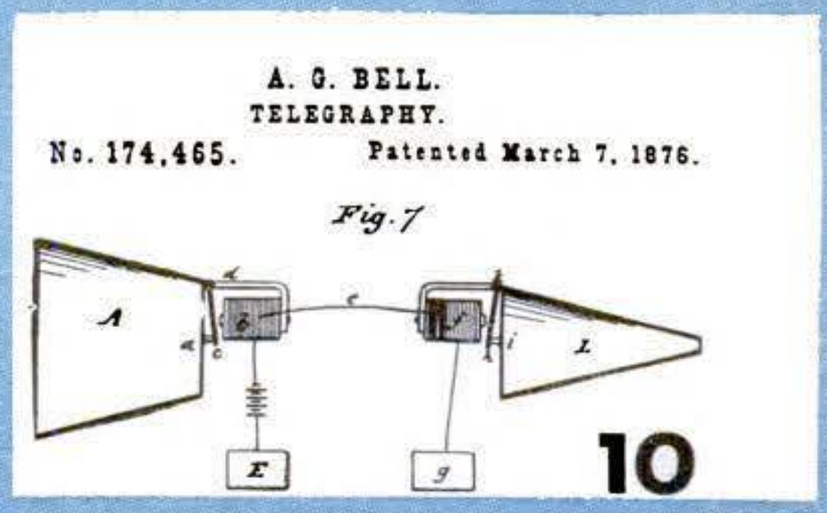
S. F. B. MORSE was a successful portrait painter for 17 years before he visited Europe in 1829 and saw the electrical discoveries of that time. Inspired by these, he lived and worked in a single room for five years while he insulated wire, made electromagnets, and invented a relay to overcome voltage line drop. By 1838, he sent messages in a dot-dash code at the rate of 600 words per hour. Morse offered his invention to the United States, British, and French governments, with no takers. Then the sending and receiving keys were developed, handling 20 to 30 words per minute. In 1843, Congress granted Morse funds for a trial, and a line was laid for 10 miles in lead pipe, with a conductor wrapped in cloth soaked with beeswax and tar. This was a failure. The line was then mounted on poles, with doorknobs as insulators, and was successful. Morse again offered his invention to the U. S. Government for $100,000. He was turned down, but private capital backed the telegraph, and it stepped up communication not only across the American continent but across the seas. Morse became wealthy and received honors commensurate with his achievement.

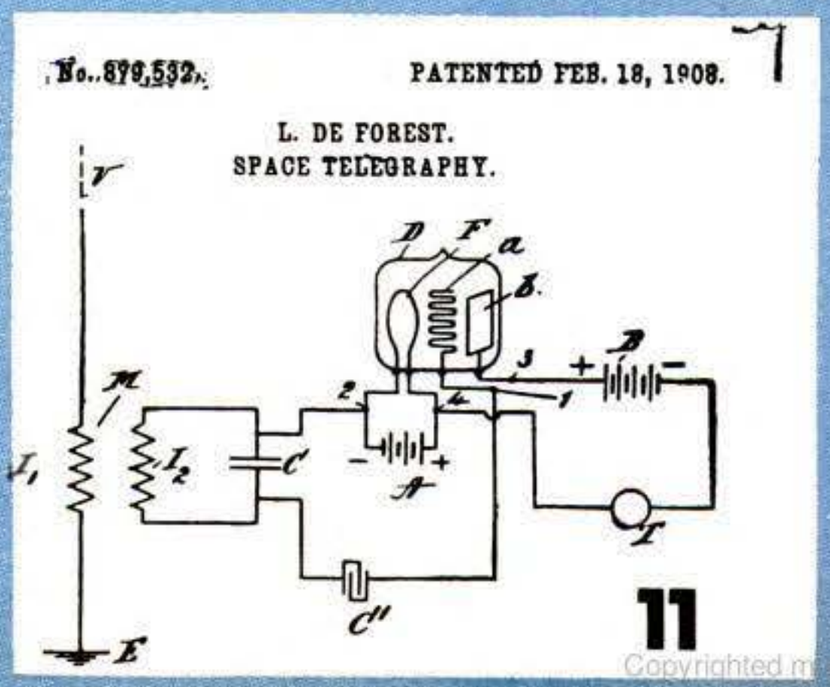
10. THE TELEPHONE 1876

ALEXANDER GRAHAM BELL, of Scotch birth, became a teacher in the Boston School for the Deaf. There he worked with devices for producing and recording sound waves, and conceived the idea of controlling an electric circuit by sound. His efforts resulted in the telephone, in which sound vibrations act on a diaphragm to make and break an electric circuit, actuating another diaphragm to produce sound at a distance. In the beginning, the Bell invention was ig-

THESE ARE THE KEYS TO MODERN COMMUNICATION







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nored; at first it was used only as a burglar and fire alarm. By August 1877, there were 778 telephones in use, but at this time the Bell Telephone Association was in financial difficulties, and offered the invention to Western Union, which did not accept. Later the inventor won litigation with the telegraph company, and Bell stock went up to $1,000 a share. The American Telephone and Telegraph Co. was formed in 1886 to include the Bell interests, and the inventor realized a comfortable fortune.

11. THE VACUUM TUBE 1908

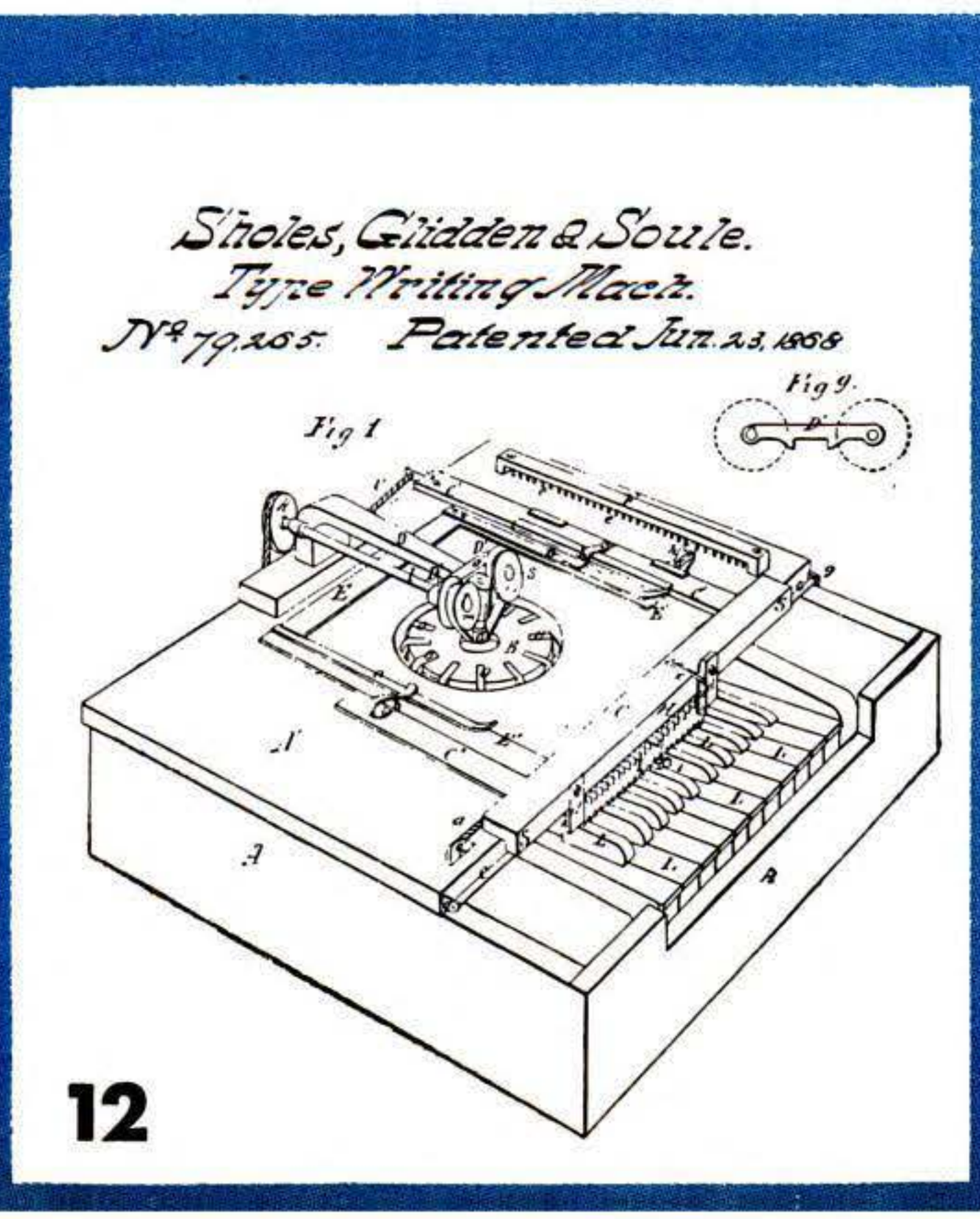
LEE DE FOREST was a minister's son with a large capacity for getting into trouble. He had difficulties of various kinds getting through schools including Yale's Sloane Laboratories. After graduation, he worked at the Western Electric Co., where he saw the iron-filings coherer that interrupted the circuit after each signal. This determined De Forest to develop a signal detector with a continuous circuit, but work on it caused him to be fired from several jobs. When he finally placed a third electrode in Fleming's diode tube, he opened the way for the entire electronics industry of the present time.

12. THE TYPEWRITER 1868

C. L. SHOLES a printer, invented a numbering machine. A friend, Carlos Glidden, said, "If you can write numbers, why not letters?" So, aided by a machinist named S. W. Soule, Sholes started to work. After five years of labor, he produced typewriters that met the objections to former devices, but the machines were not durable, and they cost $250 each. Suitable improvements in design and quality were made, after which 400 machines were sold the first year. From then on, the typewriter was a success.

13. THE LINOTYPE 1890

O. MERGENTHALER, an immigrant machinist from Germany, began in his cousin's shop in Washington. Here he worked on unsuccessful machines for typing Senate reports on paper strips for lithographing, and for embossing paper strips used in casting metal. This led to the invention of the first typesetting machine, named the Linotype, because it cast a line of type in one slug with matrices positioned from a keyboard.



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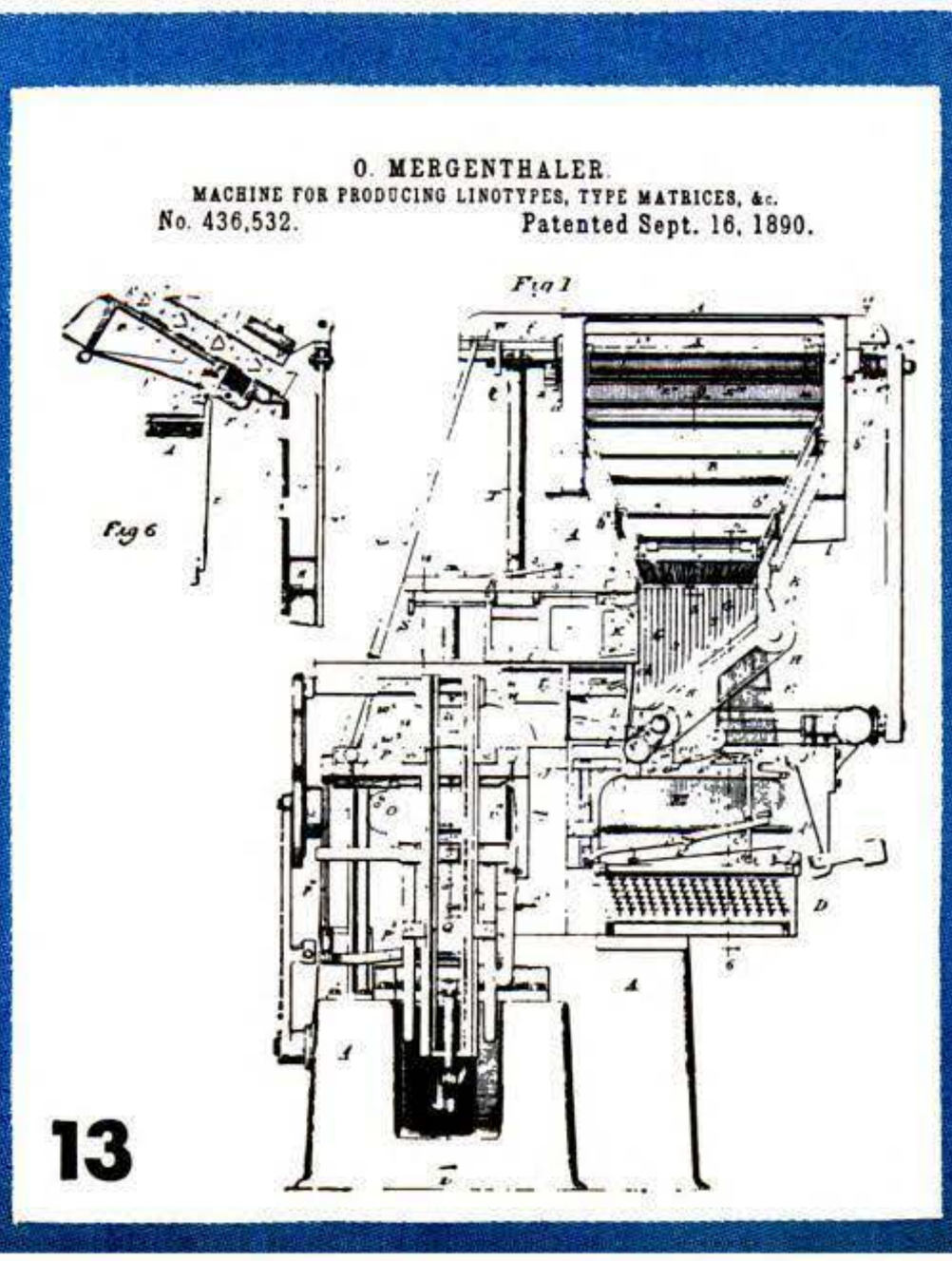

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14. THE PHONOGRAPH 1878

THOMAS A. EDISON invented the first practical device for recording and reproducing sound. While working to improve telephone transmitters and receivers, he learned the power of sound waves, and he discovered that the telegraph repeater, using an embossed paper disk on a turntable, gave off a musical note. On this basis he built a machine, after many trials, that used tin foil as the recording surface. When he demonstrated it in Boston, the public paid $1,800 in one week to see and hear it.

15. INCANDESCENT LAMP 1880

ANOTHER EDISON TRIUMPH followed a few years after the phonograph. There had been other attempts to produce a durable and effective incandescent-filament lamp, notably that of Sawyer and Mann with its carbon filament 1/32 inch in diameter. This, however, used large currents, produced only feeble light, and soon burned out. Edison succeeded in making and mounting a carbon filament 1/64 inch in diameter. This doubled the filament surface and quadrupled resistance so that a small current at relatively high voltage could be used. Having already developed 110-volt dynamos, Edison now devised sockets and fixtures, and organized separate companies for manufacturing the different parts. A new era in lighting had begun, and Edison shared in the returns.

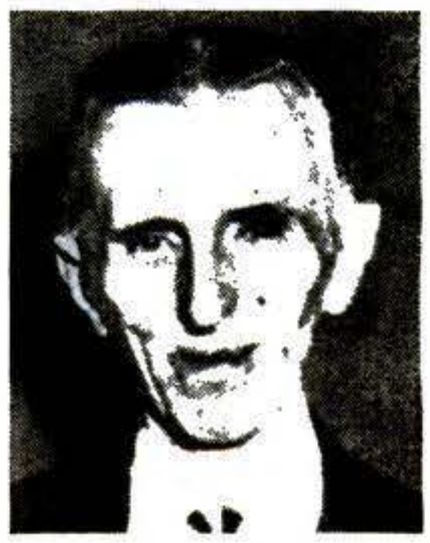
16. MOVIE PROJECTOR 1893

EDISON FAILED TO CASH IN with his invention of the motion-picture projector because it appeared too soon. Others had projected pictures at rates varying from 12 to 32 per second to take advantage of the well-known optical phenomenon called persistence of vision. Edison determined that the correct speed for optical continuity in the projected pictures was 16 frames per second. Then he developed a film drive and shutter mechanism to attain that speed, together with a means for shielding the film from the heat of the lamp, and a proper lens system for focusing the pictures on the screen. At the time of the invention, there was no serious attempt to introduce it to the public.

17. ALUMINUM 1889

CHARLES M. HALL was a minister's son. As a boy he read about aluminum in his father's books. He studied chemistry at Oberlin College, where his interest in aluminum was reawakened by seeing the metal produced by a known chemical method at a cost of $8 per pound. After graduation, he conceived the idea that fused aluminum ore could be electrolytically separated. Then he discovered that molten cryolite would dissolve bauxite, and he put his theory to a test that proved successful.

18. INDUCTION MOTOR 1888



NIKOLA TESLA, a Croatian-born electrical engineer, came to this country in 1884 as a dynamo designer. At that time there were no practical small A.C. motors, and individual machines in factories were powered from shafting and belts. Tesla solved the problem of consequent waste of energy by inventing the induction motor, which made unit drives for machines feasible. The motor had a rotating magnetic field that eliminated the need for a commutator and brushes. Westinghouse bought the patent rights to the invention, one of 700 credited to Tesla.

19. "BAKELITE" 1909

LEO H. BAEKELAND taught chemistry and physics at the University of Ghent, Belgium, until he came to the United States in 1889. He invented Velox, a photographic paper, and when its manufacture became a going business, he sold it to the Eastman Kodak Co. He then turned to work in synthetic resins. After 12 years, he found that phenol and formaldehyde, when heated under pressure, produced an amber transparent material that molded perfectly. The name "Bakelite" honors the inventor.

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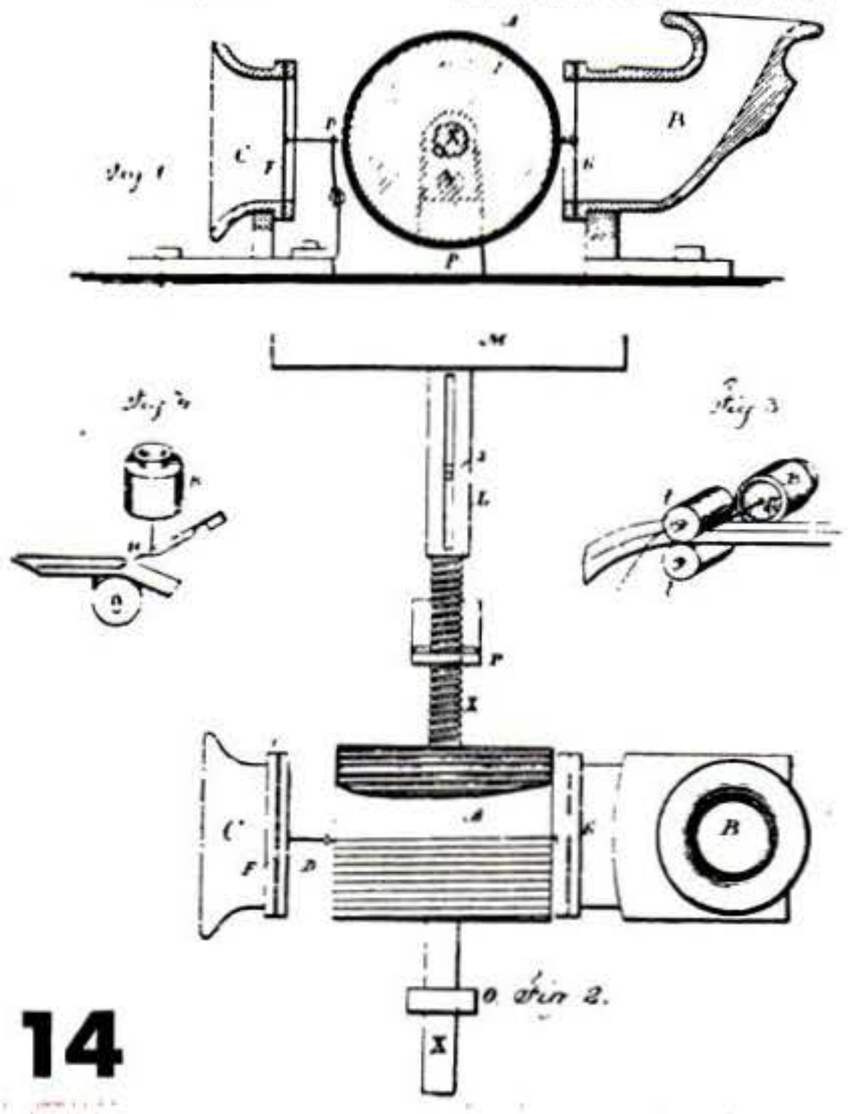
THESE BROUGHT NEW PLEASURE AND COMFORT

T. A. EDISON.
Phonograph or Speaking Machine

No. 200,521 Patented Feb. 19, 1878.



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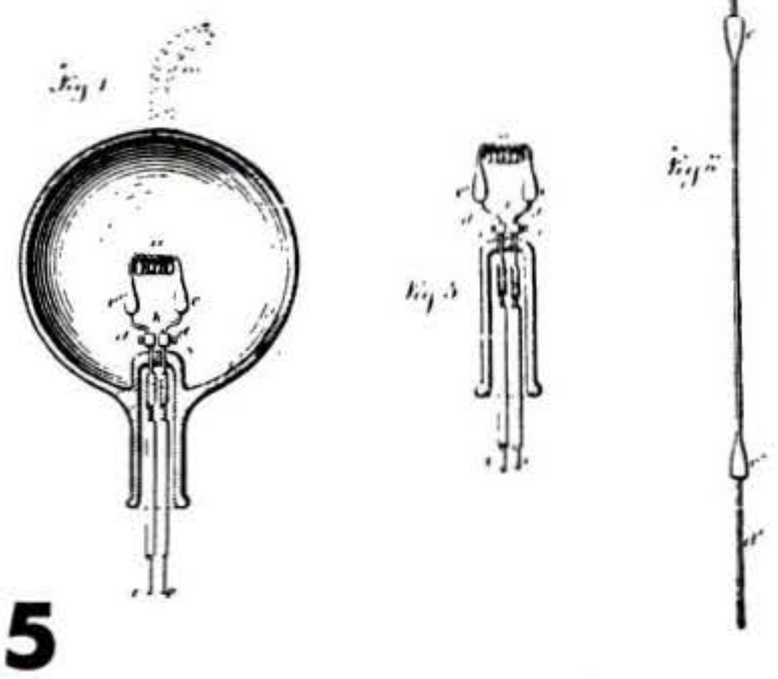
T. A. EDISON
Electric-Lamp

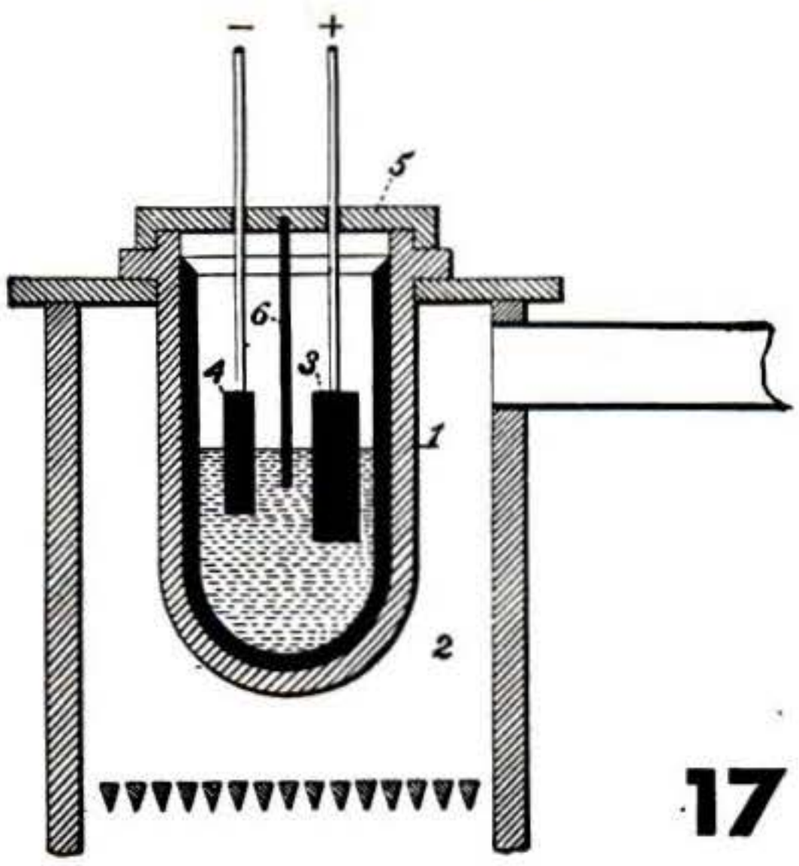
No. 223,898. Patented Jan. 27, 1880



15

C. M. HALL.
MANUFACTURE OF ALUMINIUM.

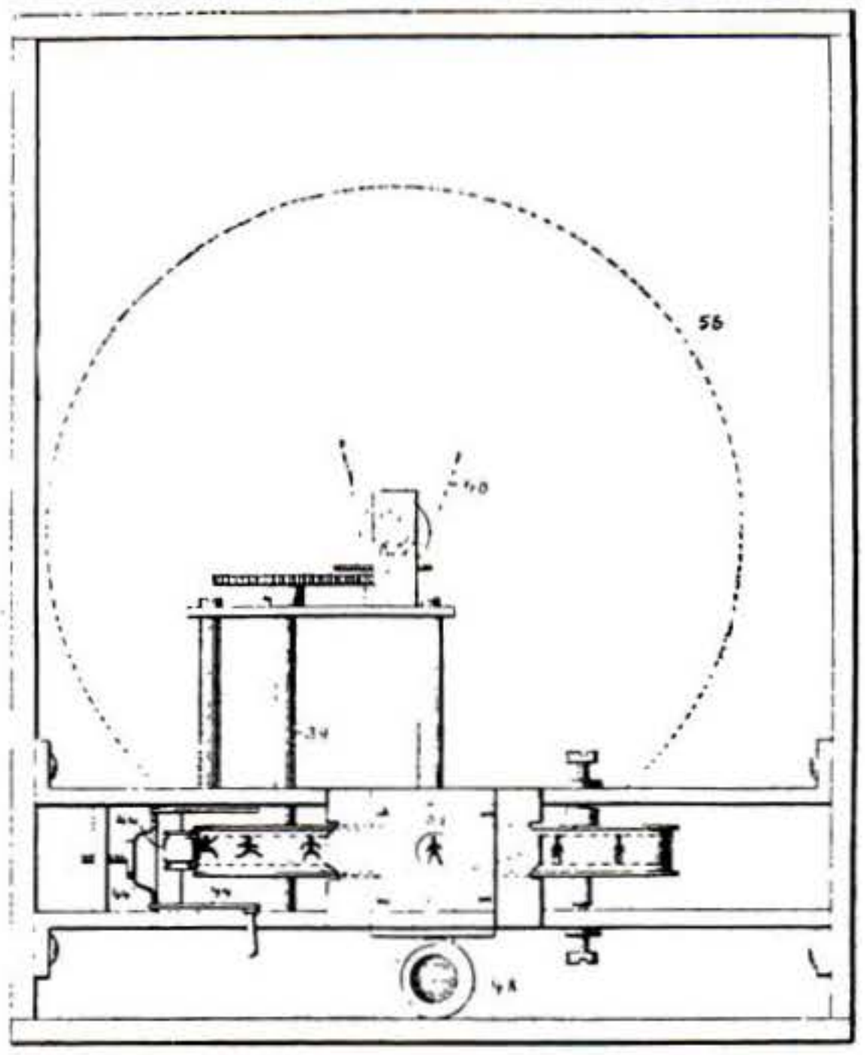
No. 400,665. Patented Apr. 2, 1889.

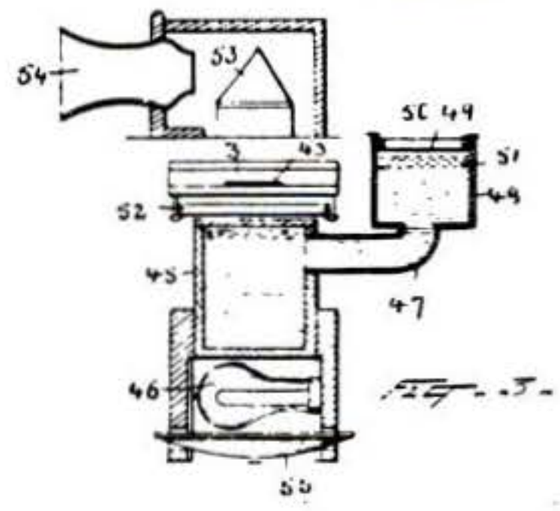


17

T. A. EDISON.
APPARATUS FOR EXHIBITING PHOTOGRAPHS OF MOVING OBJECTS.

No. 493,426 Patented Mar. 14, 1893.





16

N. TESLA.
ELECTRICAL TRANSMISSION OF POWER.

No. 382,280. Patented May 1, 1888.

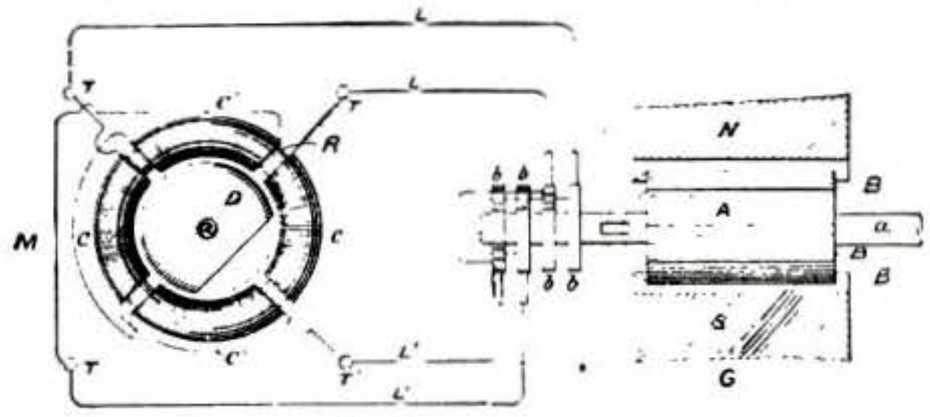


Fig. 9

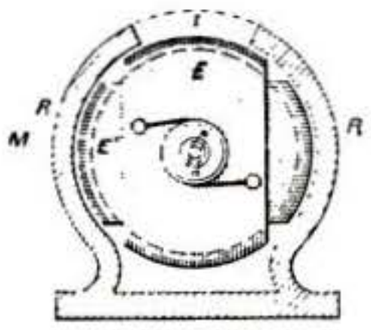


Fig. 10

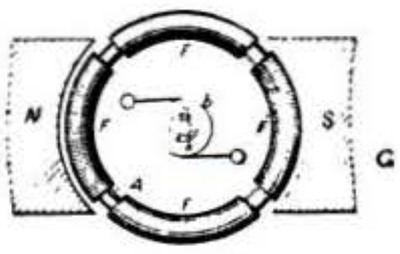


Fig 11

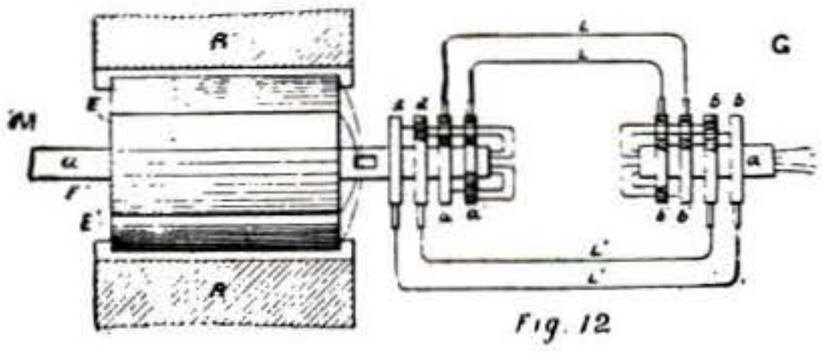


Fig. 12

18

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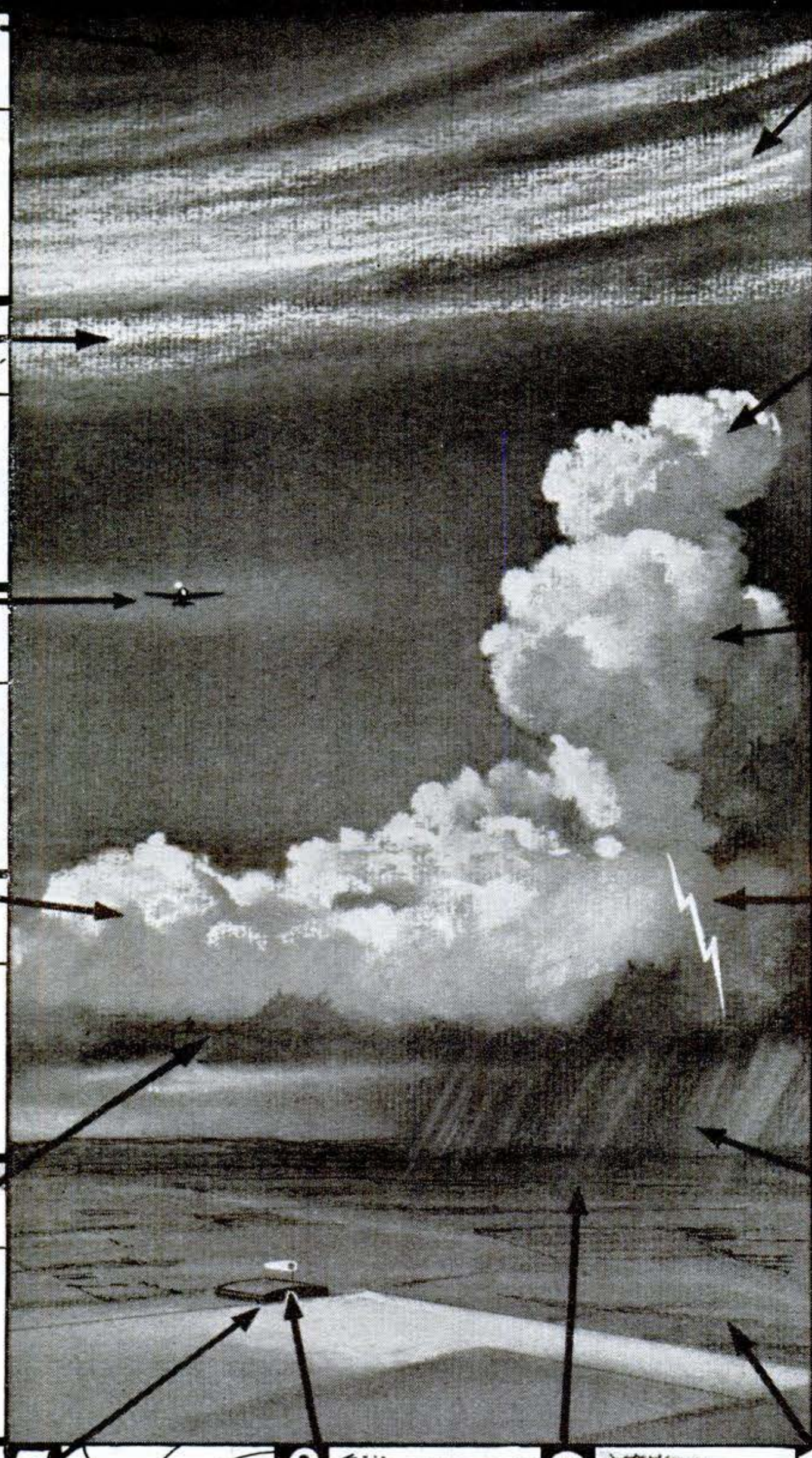
How Good a Weather Prophet Are You?

Put a check mark beside the statements you think are true, a cross beside those you think are false. Then grade yourself.



1 The weather blanket that is spread over the surface of the earth is about 100 miles high.

2 A very high, solid cloud roof heralds a warm invading mass of air—a "warm front."

3 The altimeter does not measure height above land, but above sea level.

4 Ice forms fastest on the wings of an airplane inside billowy cumulus clouds.

5 In speaking of the cloud ceiling, aviators refer to the top of the cloud formation.

6 Warm-front rain lasts longest, while rain from a cold front is of shortest duration.

7 Close - together isobars on the weather map are indications of lowest winds.

8 Winds near the earth's surface usually attain the greatest velocity.

9 Rain falls most readily from the clouds that hang low in the sky.

10 The atmospheric pressure on one square yard at sea level is about 10 tons.

11 Rain usually falls in areas where the air pressure is highest.

12 Lightning is a great menace to passengers in all-metal airplanes.

13 The thunderhead has a vacuumlike core of still, rarefied air.

14 Hailstones originate inside of the cumulo - nimbus cloud formation.

15 The correct scientific name for this "mare's-tail" formation is "stratus."

TURN TO PAGE 207 FOR ANSWERS

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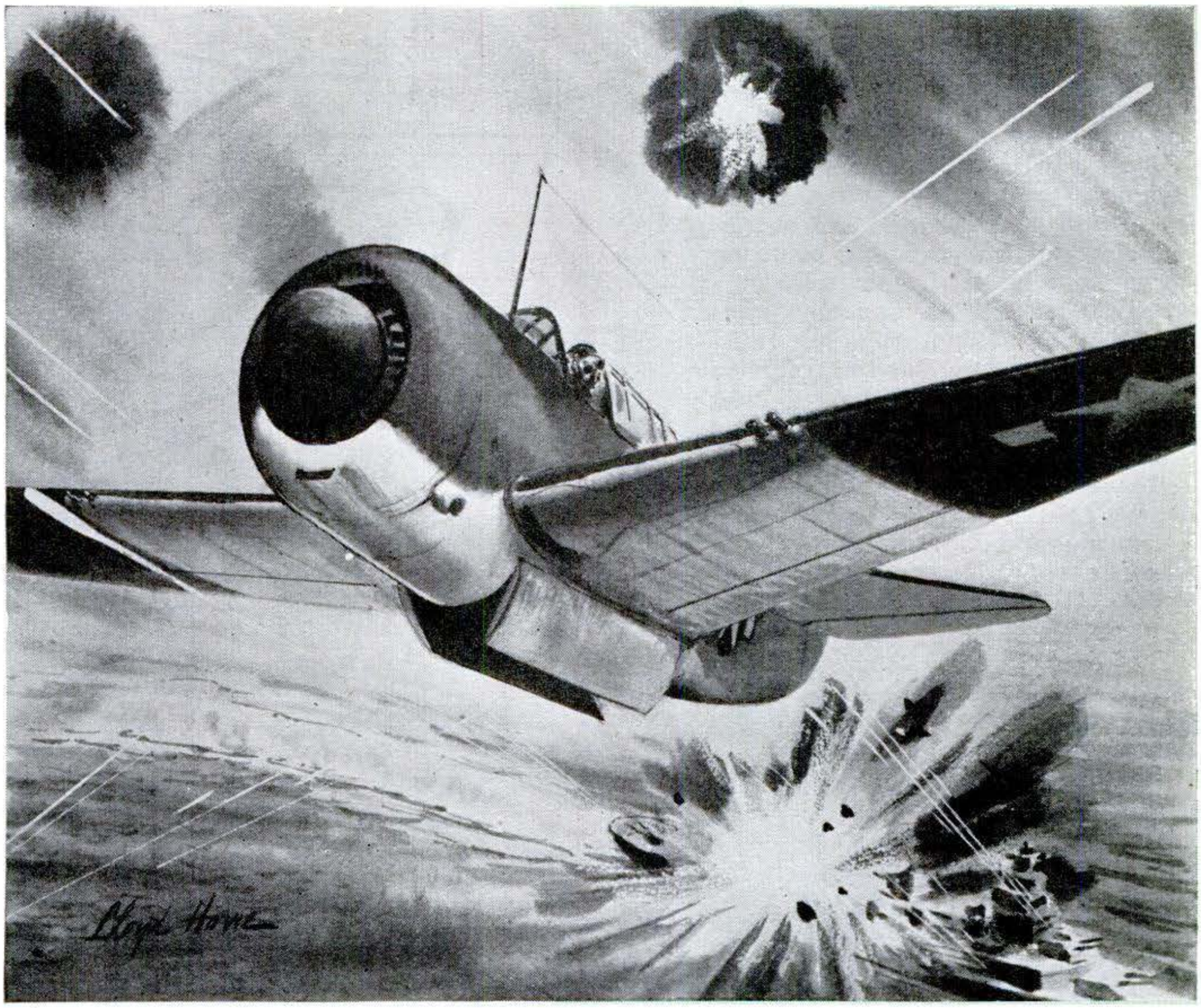

I Ride "the Beast"

By Lt. Comdr. JOSEPH W. RUNYAN, USNR

As told to ROBERT E. MARTIN

Climb into a Helldiver's cockpit and share the thrills of one of the strangest battles of the war.

TWENTY-NINE BOMBS painted on the side of his Curtiss Helldiver stand for 29 combat strikes that Lieutenant Commander Runyan has made against the enemy in the Pacific. He flew more combat hours than any other member of his squadron. Why? Because every time his name was taken off the flight schedule he would slip back and put it on again. He has been dive-bombing eight years. The group of which his "Bombing One" was a part destroyed 205 enemy planes, damaged three carriers, sank four other warships and damaged three, sank 11 cargo ships and damaged 16, silenced 56 AA batteries, and messed up countless fuel and ammunition dumps, warehouses, and barracks. He is now on duty in the U. S.

AT THE aft end of the carrier deck some of our Helldivers sat packed together, hunch-shouldered against the wind like cattle sharing the warmth of their collective bodies. Below, stored in the cavernous hangar deck, were other dive bombers, ready to be wheeled quickly on the elevators.

We knew that it wouldn't be long now. We were entering the combat area of the western Pacific, bound for what was to prove to be one of the strangest engagements of the war.

Everything belied it. Some of the pilots and air crewmen lolled in their quarters or in the ready room. Others monosyllabically played poker.

"Bombing One," as our squadron

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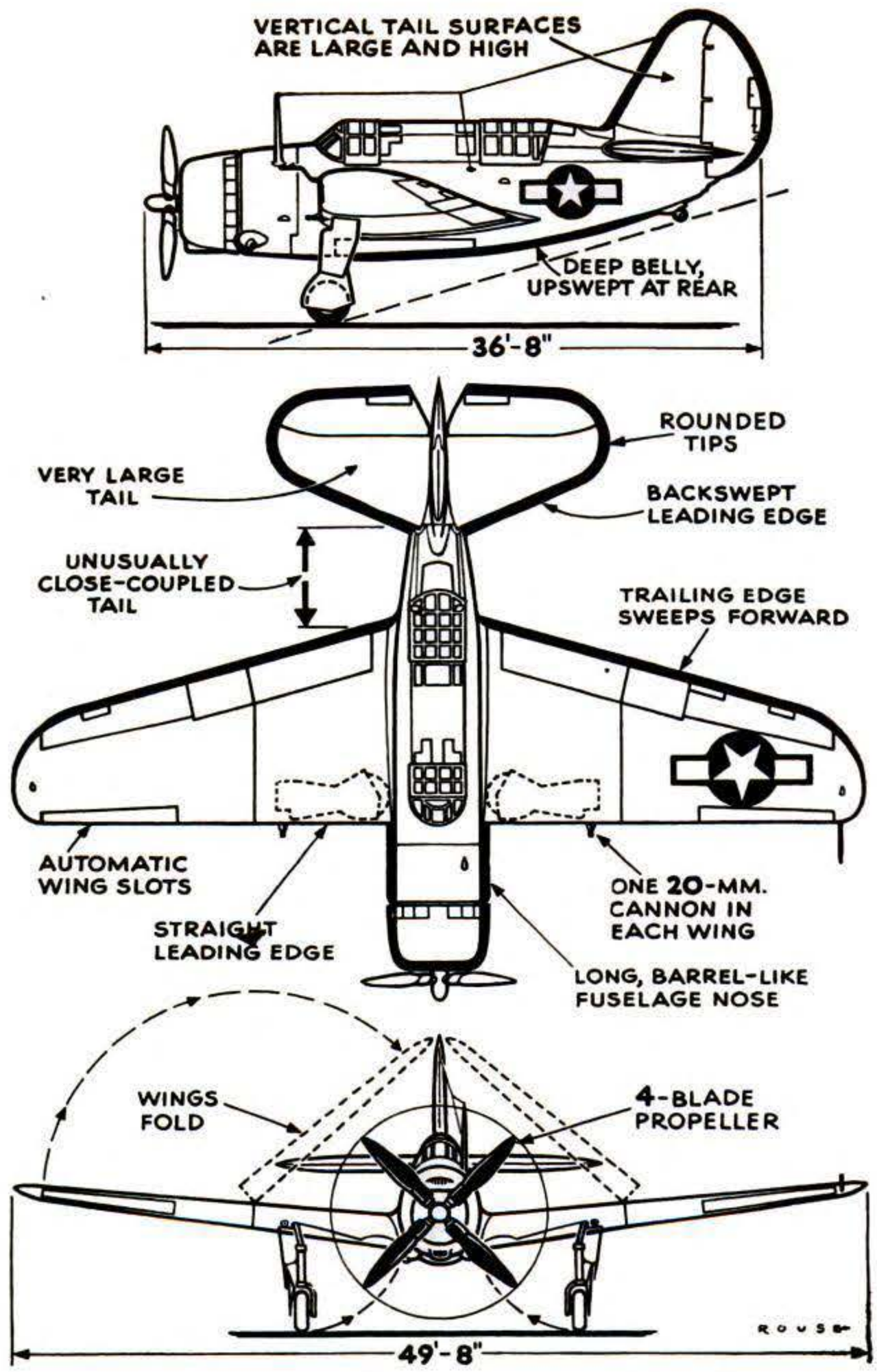
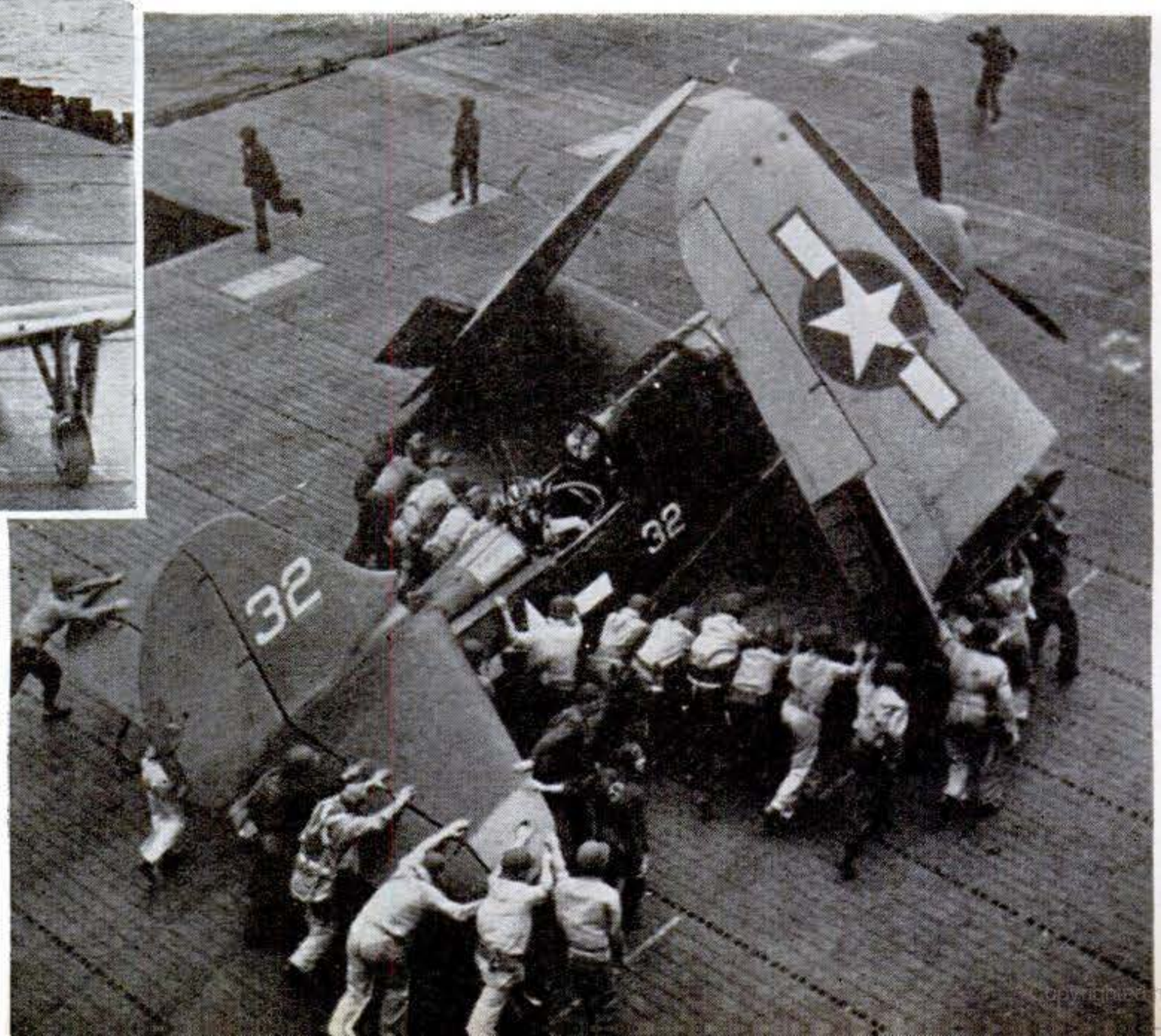
was called, had trained hard for this hour. We had new-type dive bombers, faster, more heavily armed than the carrier-borne bombers that had been thrown at the Japs in the critical battles in the Pacific earlier in the war.

Our Curtiss SB2C Helldivers, weighing some seven tons apiece, were built to withstand the strains of hard pull-outs and of bouncing deck landings when our carrier—which must remain unnamed—was pitching and rolling. It is one thing to put a plane down on an airport on solid land, and another thing to do it on a landing field that won't stand still.

These planes were "the beasts." Where the term came from I don't know, unless it derived from the big fuselage (wholly enclosing the bomb), the skyscraper fin, and the



HELLDIVER is easily identified by its squat, stubby look. Characteristic features are the straight leading edge and forward-sweeping trailing edge of the wing, the short distance between wing and oversize tail, and the deep belly



OFF AND ON. A Helldiver zooms away from a U. S. Navy carrier while a sister plane lands and taxies to its berth after a dive-bombing and strafing blow at the Japs. At right, a returning plane is pushed toward an elevator that will lower it into the hangar. Note the outspread diving flaps on the upward-folded wings

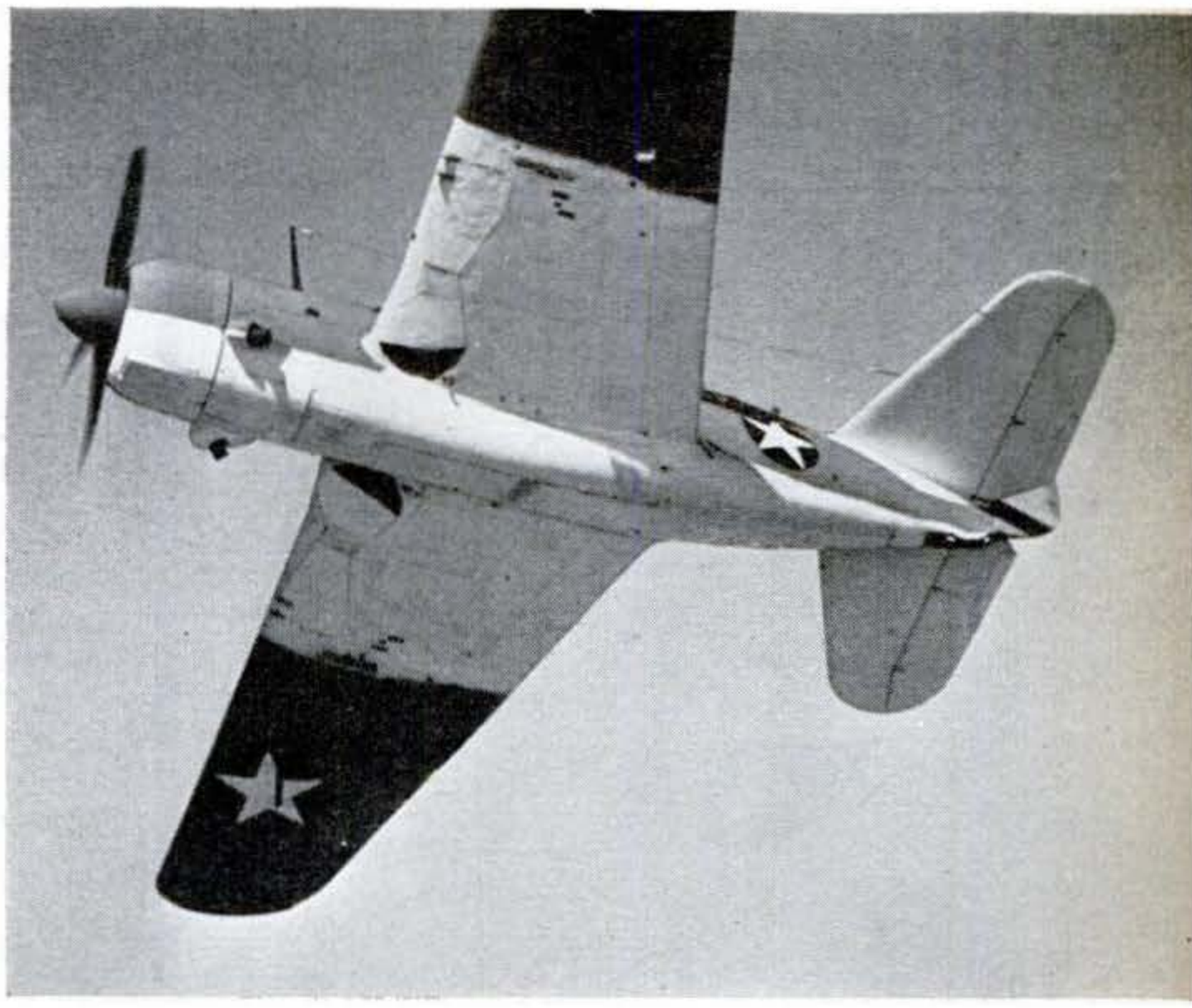
engine with its barrel-like cowling, which was as big as 10 wash tubs.

They had other attributes. They carried a 20-millimeter cannon in each wing, affording high firepower against enemy planes and ground installations. These were the first cannon ever fitted to an American dive bomber in the 16 years that the Navy had practiced the art. They also were the first to be mounted on a carrier-borne plane.

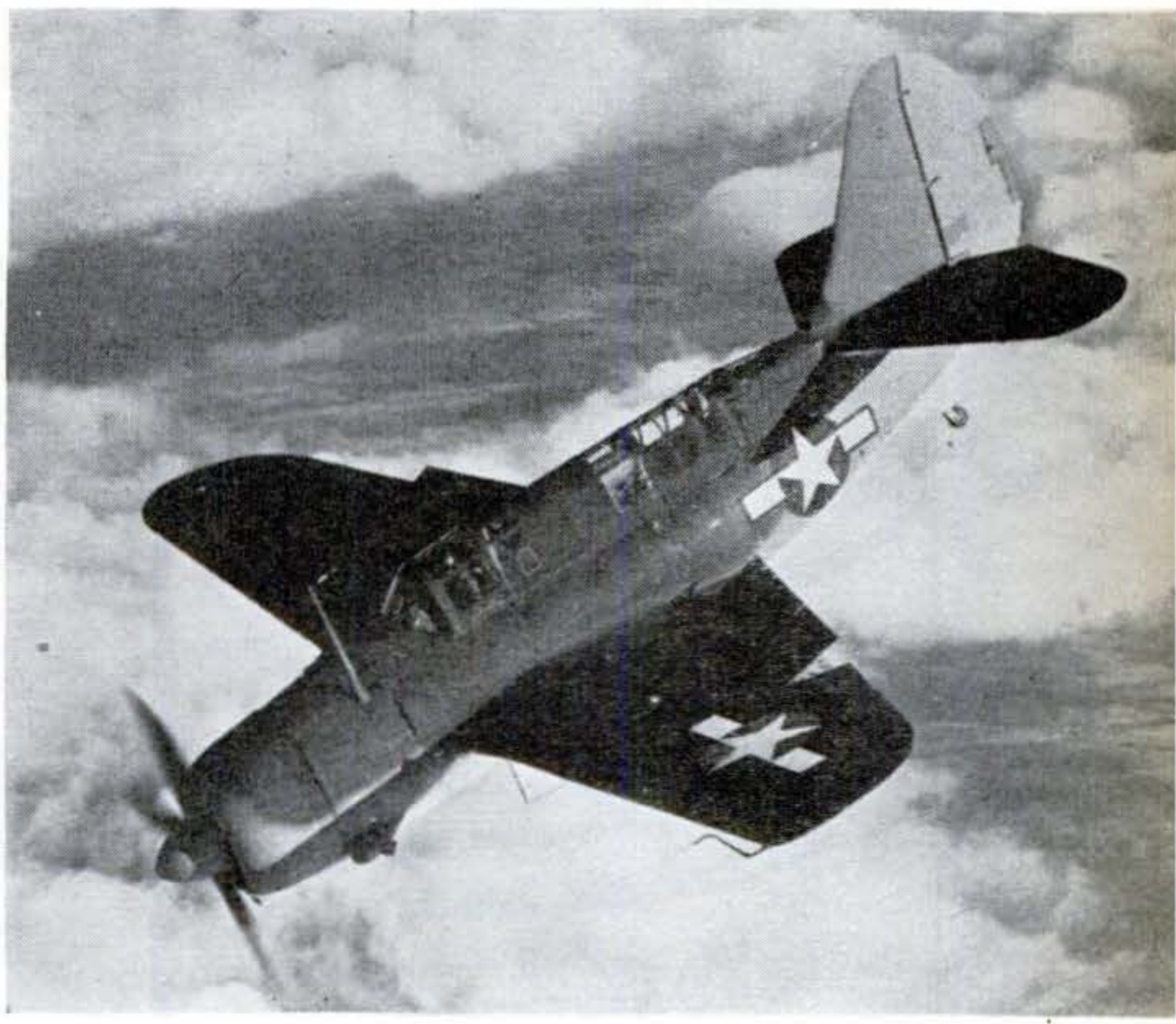
In addition to the 1,000-pound bomb carried in the belly, there were two 250-pounders under the wings. Protecting the pilot and rear gunner were 150 pounds of armor plate.

The Helldiver had been born in a cattle barn on the Ohio State Fair grounds at Columbus as the Curtiss company pushed its manufacture in temporary quarters while a new factory was being erected. The project director, Raymond C. Blaylock—who, by the way, had worked on the F8C, the original Helldiver, the first plane to be built specifically for dive bombing when the Navy was evolving the technique between 1927 and 1930—managed hundreds of modifications dictated by Pacific battle experience.

My squadron knew what its job was to be. The dive bomber and the torpedo plane constitute the Navy's one-two air punch. Their co-ordinated attack is the only type that has been evolved with weight enough to break *(Continued on page 205)*

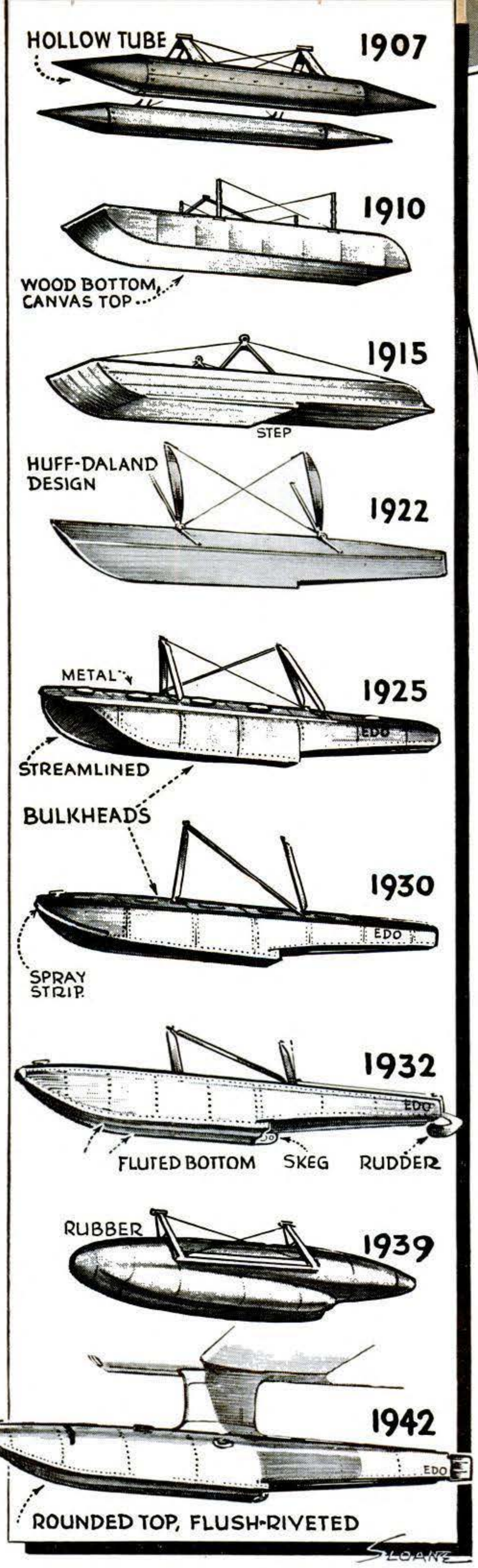


CONCEALED BOMB. First dive bomber to carry a bomb in its fuselage, the Helldiver packs a 1,000-pound package of destruction in its belly, two 250-pounders tucked under its wings

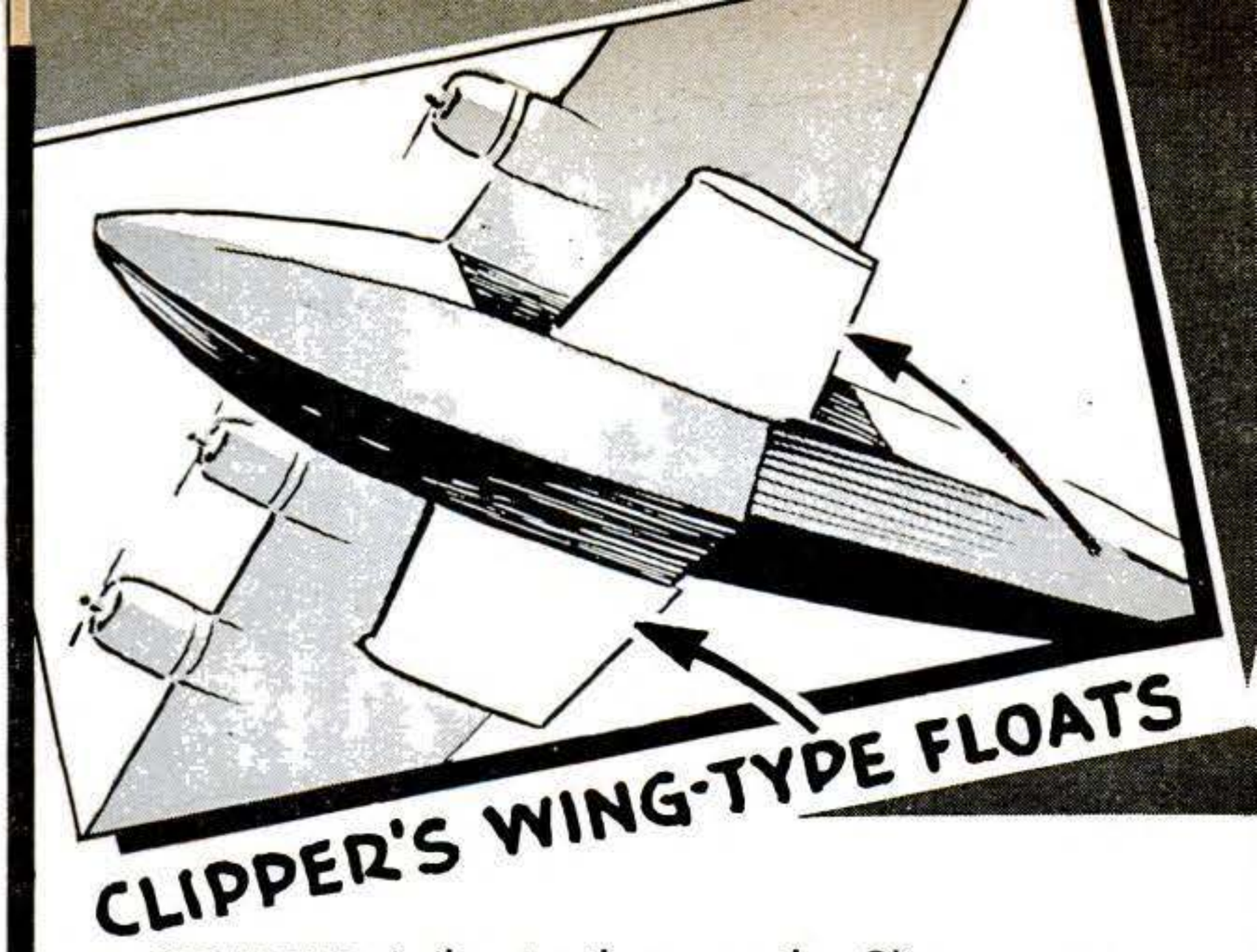


DIVING. An SB2C heads over in a dive. The opened wing flaps, or air brakes, are designed to slow the plane in its headlong descent and give the pilot better control

THIRTEEN MEN (test pilots at the Columbus, Ohio, Curtiss-Wright plant) line up on the wings of a Helldiver to show its size. This, a later version than the one flown by Lieutenant Commander Runyan, has a four-bladed prop, more powerful engine



FLOAT EVOLUTION over the past 38 years. In 1915 came the "step," which reduced suction and enabled ships to get into the air easier. 1932 model is used on private planes; '42 on commercial ships



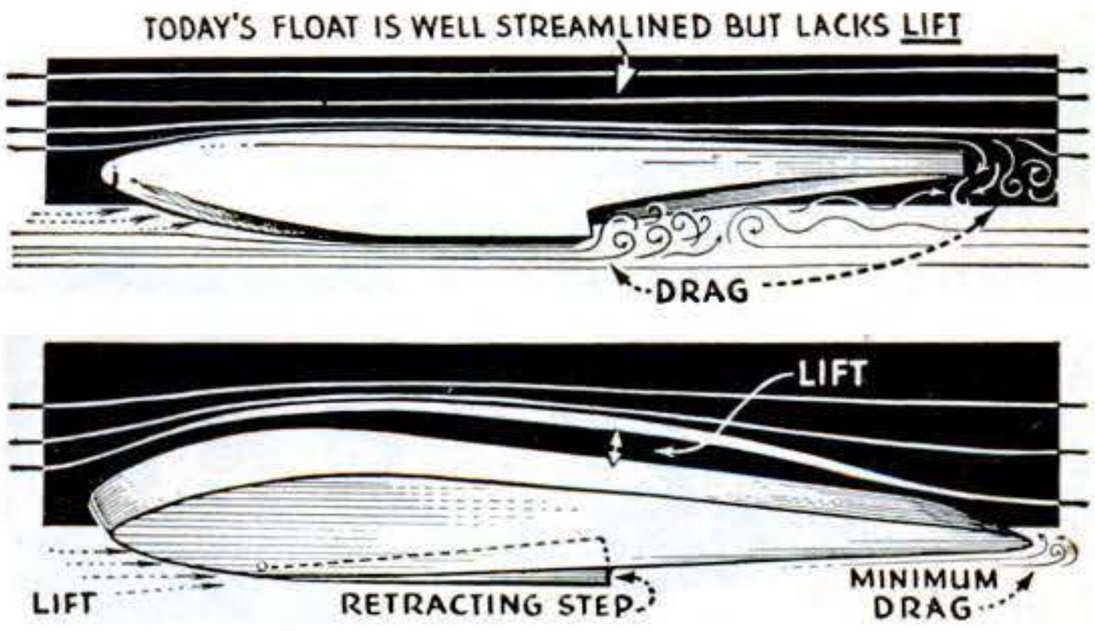
SPONSONS similar to those on the Clippers may one day become part of the seaplane. By adding lift, they help counteract their own drag.

Will a Lake Be Your Postwar Landing Field?

Drawings by ERIC SLOANE

IN THE search for a safe, handy plane that will be popular with private owners in postwar years, the seaplane must not be overlooked. Operating from water, it has three quarters of the earth for a landing field and can take off in low-ceiling weather in which it would be both unsafe and illegal to fly a land plane. Terminal "runways" are already built, for nearly every important city lies near a sizable body of water. By merely fitting its floats with wheels, it can be made amphibious. Students also find that when they practice in the calm air and waters and unobstructed stretches of a harbor, flying is a lot safer and easier to learn than over the all-too-solid earth.

WING-SHAPED FLOAT. Instead of endeavoring to streamline away float drag, some observers suggest the float be built like a wing section, with a hinged step that can be retracted after take-off



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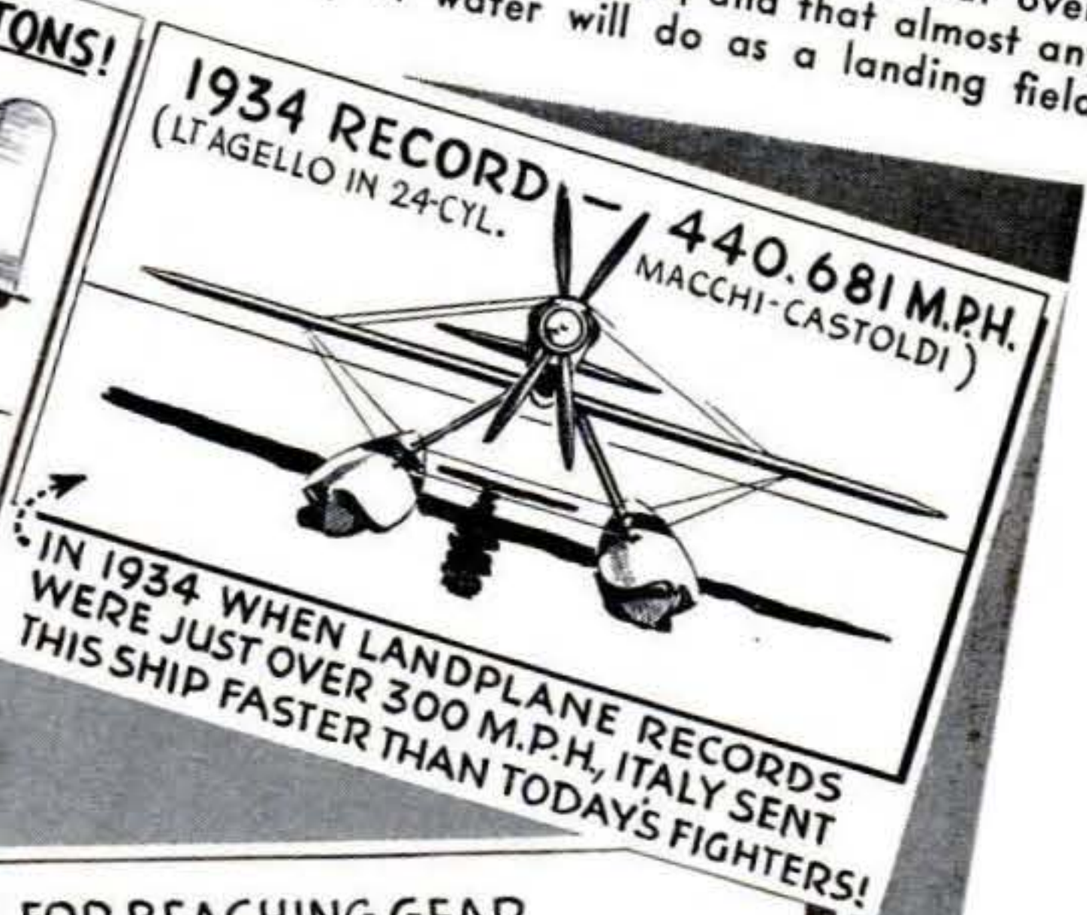
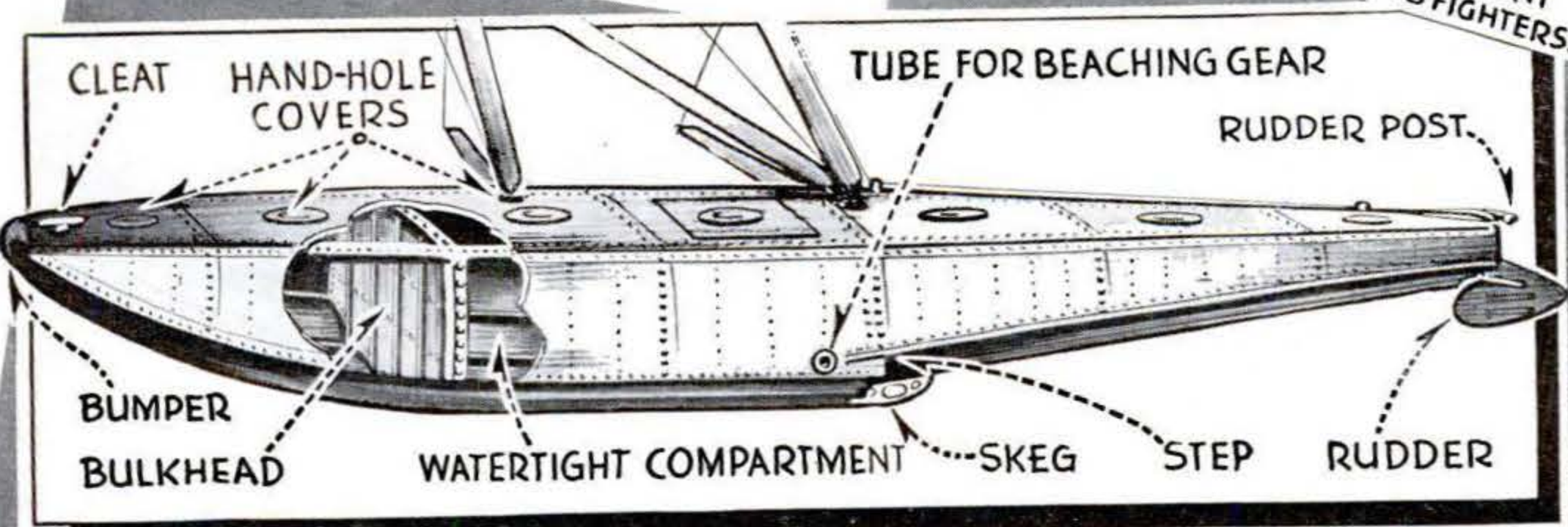
SEAPLANE FLYERS have the advantage of being able to find "runways" near almost every big city, of having a lot of elbow room on the surface, and of using direction of the waves as a "wind sock"

OTHER ADVANTAGES for the seaplaner are that he can alight on dry land if necessary, that over-water air usually is fairly calm, and that almost any near-by body of water will do as a landing field

HIGH SPEED RECORDS have been made by seaplanes. Unlike fast land planes, swift seaplanes have an easy time finding runways sufficiently long





ALL-METAL AIRPLANE FLOAT SHOWING COMPARTMENTS

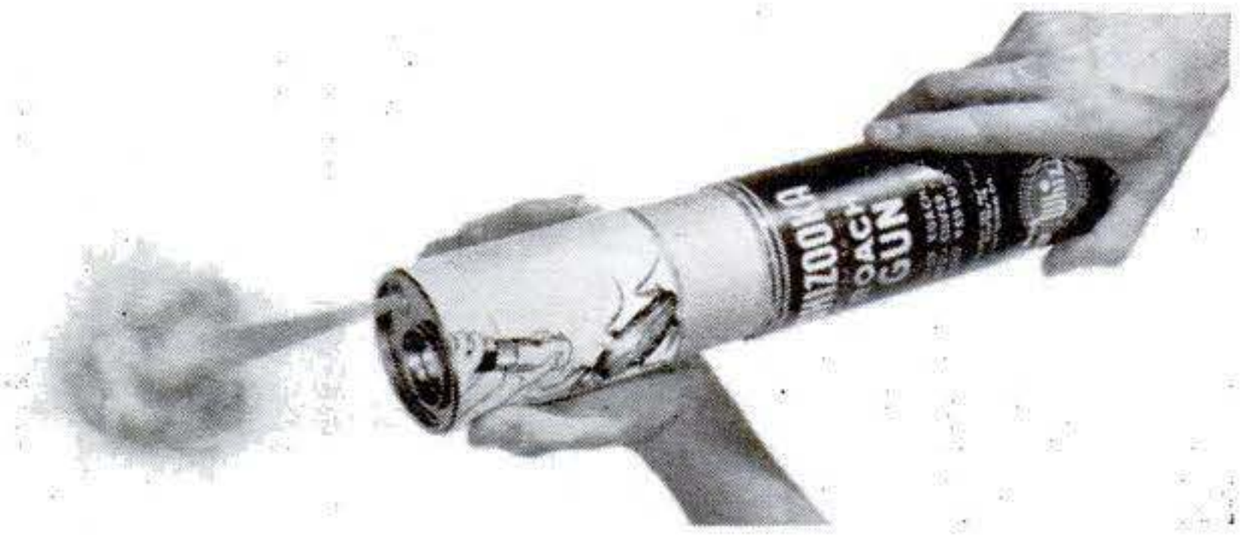
FLOAT CONSTRUCTION includes flush riveting, salt-water-resistant materials, and a design that often makes the float even sturdier than the plane

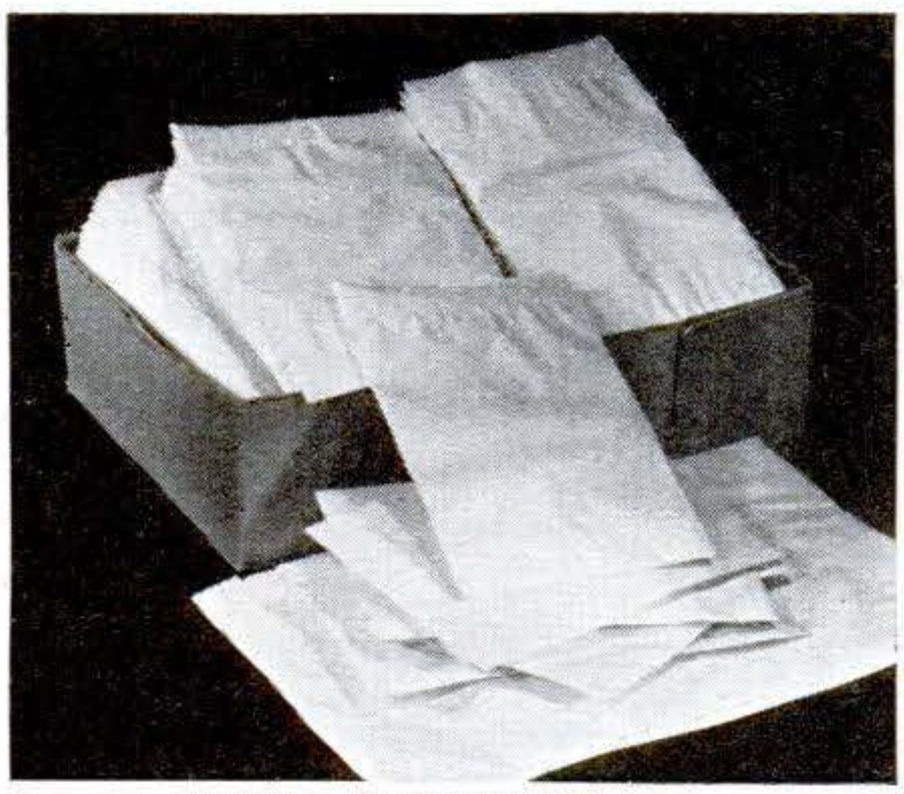
What's New in Modern Living

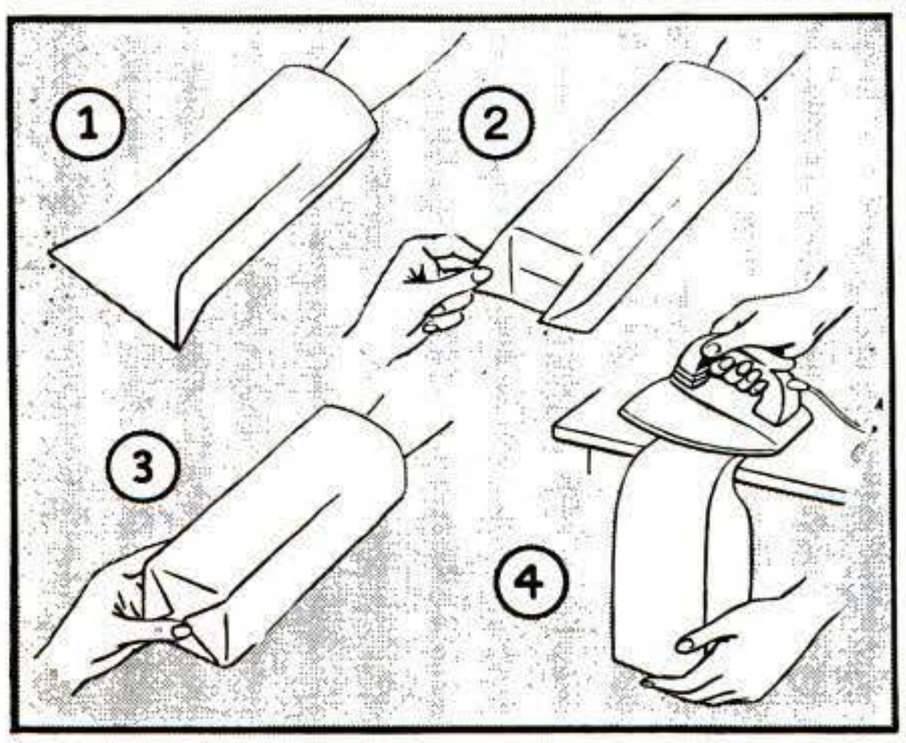
CHAIRS OF PLYWOOD are as comfortable to sit in as they are handsome and decorative. A single sheet of this versatile wood product is curved under special treatment to form a sturdy seat and back. It is set upon two sidepieces that serve as legs. The modern chair shown in the photo was put on display recently at an industrial designers' show in Detroit.

SYNTHETIC INSECT POWDER, packed in a container that also serves as a spray gun, has recently appeared on the market. The container is in two telescoped sections that are pumped to force out a cloud of powder. R. M. Hollingshead Corporation, of Camden, N. J., is the maker.

MOISTUREPROOF SACKS for sealing up dehydrated and frozen foods and for icebox storage of butter, cheese, meats, and the like are available at Lewis & Conger in New York. The containers are made of a lined, durable kraft paper. Food is put in carefully to avoid soiling the opening, which is then sealed up tight simply by pressing the edges with a hot electric iron.







RECHARGEABLE FLASHLIGHT BATTERIES that are similar in principle to an automobile storage battery are now available for industrial users. They require a special 1.9-volt, .6-amp. Mazda lamp, available with a screw or flange base. This lamp has about twice the current draw of the type used with dry cells, but is said to give a distinctly brighter light. B. F. Goodrich Company, of Akron, Ohio., the maker, also reports that one wet cell will outlast 400 of the ordinary dry cells.

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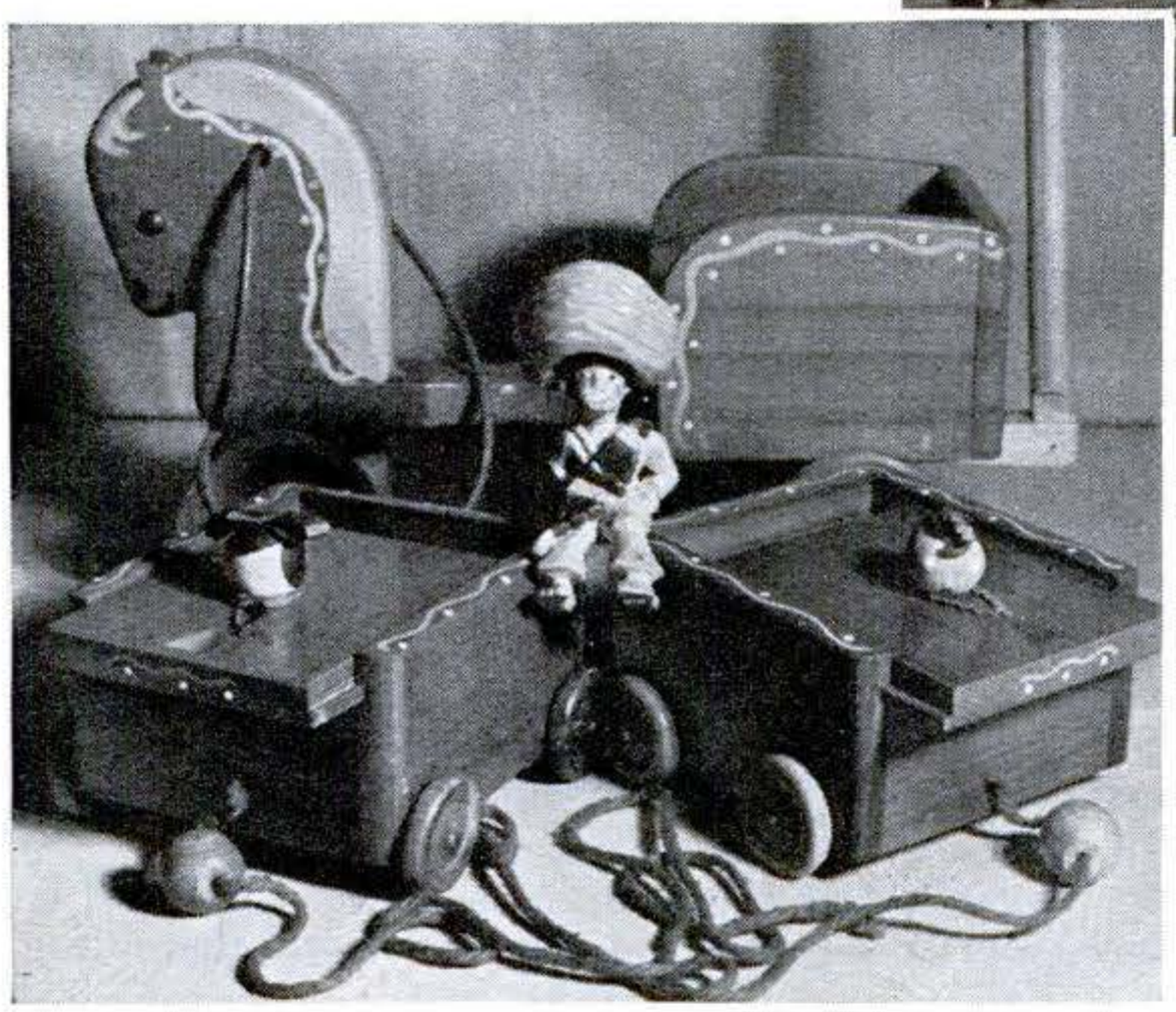
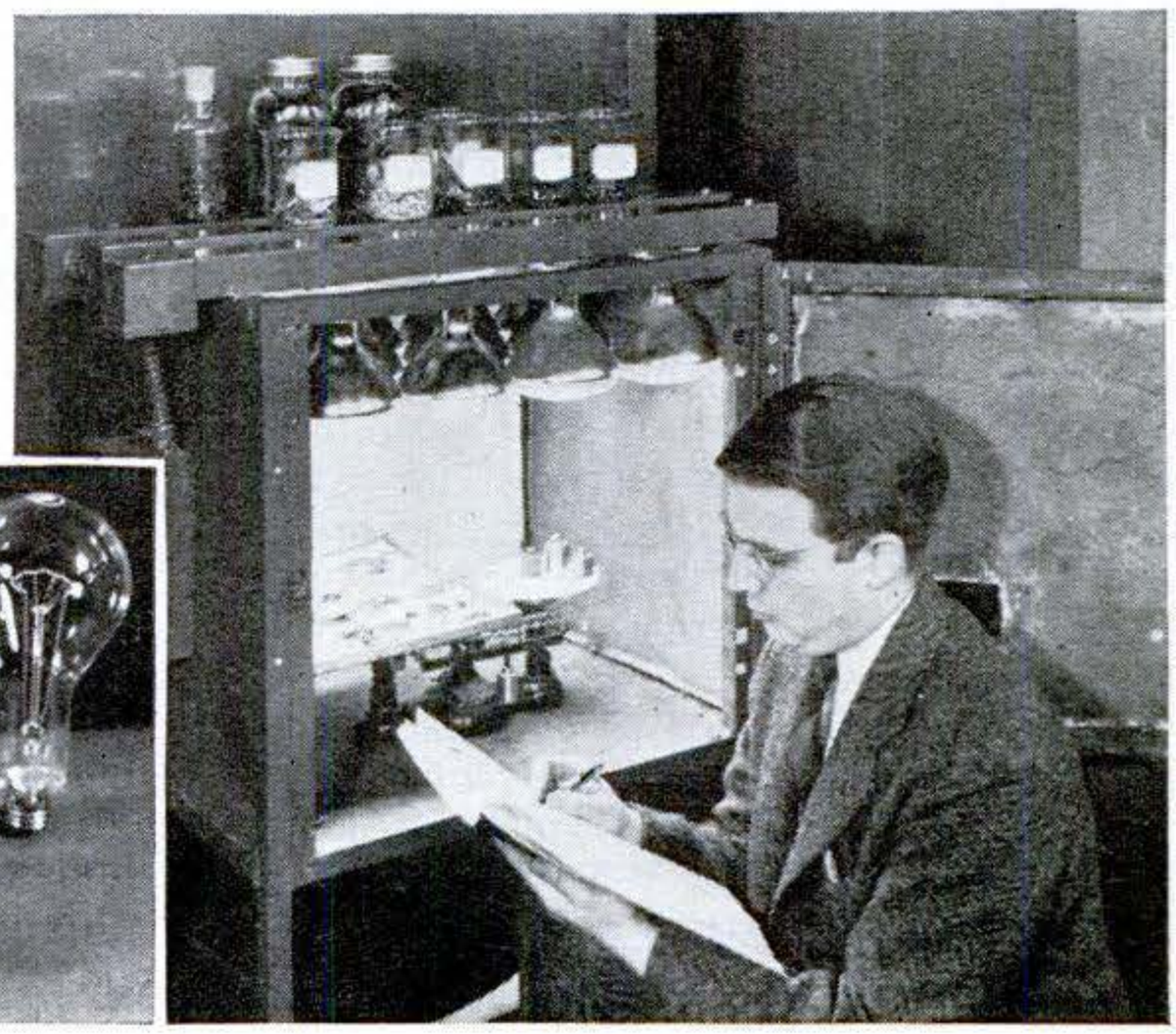
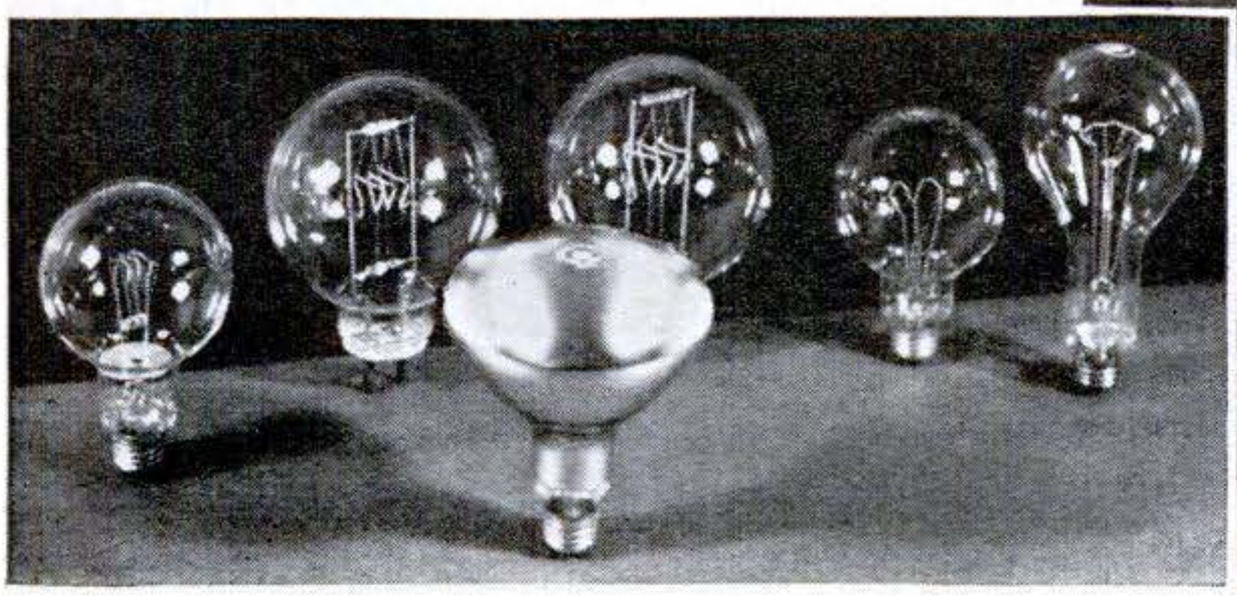
REDWOOD AND CERAMICS are being employed by California makers of toys and decorative figurines. The ornaments displayed at the right show the use of both wood and ceramics by Barnware, of Hollywood. No metal other than a few pins for joining was required in making the sturdy redwood pull toys shown below. The all-redwood rocking horse is made by Woodies from California, of Los Angeles.



LIGHTNING-FAST DEHYDRATION of food has been developed by a group of engineers at Vanderbilt University in Nashville, Tenn., using infrared lamps to cut the process from 20 hours to 20 minutes. A battery of General Electric lamps like those shown below are installed in the top of the oven. Speed is accomplished through a high rate of heat transfer. The food must be cut into small pieces to avoid scorching outer surfaces while water is being driven out. F. M. Tiller, who with E. E. Litkinhouse and Wilfred Turbeville, developed the process, is shown at the right with a test oven heated by the lamps.





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Gus Beats

Gus looked at the clipping. "Small used to stop by," he said

By MARTIN BUNN

STATE Trooper Jerry Corcoran, his boots mirrorlike as usual, his sheepskin coat buttoned against winter winds, and his wide-brimmed hat at its habitual devil-may-care angle, regarded his friend Gus Wilson with the haggard eyes of a weary and worried man.

"What's the matter with you?" Gus demanded. "You look as gloomy as a funeral."

"I'm gloomy because I'm trying to prevent a funeral—and I'm not making such a hot job of it," Jerry answered. He took some papers from his pocket and passed one over. "Remember that?" he asked.

Gus looked at the newspaper clipping and nodded. "Poor Hank Small," he said. "Used to stop by when he had a taxi—before he started driving a truck for the Victory plant. Went to sleep and ran off the road."

"Broke his neck," Jerry agreed grimly. He handed Gus another clipping.

"I remember this one, too," Gus said. "Same kind of accident. I didn't know Sam Schwartz."

Jerry lit a cigarette. "Do you see anything queer about those two wrecks?"

Gus shook his head. "Why, no," he said, "unless it is that both drivers worked for the same concern and were killed in accidents of the same sort within a few weeks of each other. Hard luck runs in streaks."

"Yes," Jerry assented. "We figured it was just a hard-luck streak, too." He handed Gus a folded sheet of paper. "But not after about a week ago when every driver who works for the Victory outfit got one of these."

Gus unfolded the paper. It was a ruled sheet torn from a cheap pad, and on it was a single line of penciled printing that read:

IT WILL GET YOU TOO

Gus whistled softly.

"We haven't any proof," Jerry said, "but we're pretty sure we know the guy who printed that. He's one of the drivers—calls himself William J. Smith. There's nothing against him except that before Pearl Harbor his name was something else and he belonged to the Bund. But last night they had another wreck of the same sort. Fortunately it wasn't fatal. You know Fred Gaskell?"

"He belongs to my bowling club," Gus said. "He's been working in the Victory plant ever since it opened, but he doesn't drive a truck. He's in charge of their fleet."

"Last night he drove one," Jerry told him. "Took the place of a fellow who lost his nerve when he found one of those warnings in his overall pocket. The Victory people have to make deliveries to a plant out of the State seven nights a week—they make parts for something the Army needs quick. That's why the G-men are interested.

"Gaskell wasn't badly hurt, and his truck was only partly wrecked," Jerry explained. "It's being towed here. We want you to go over it before anyone else does. O.K.?"

"Of course," Gus agreed. "I'll help if I can . . . Those other two accidents were investigated, weren't they?"

"Yes," Jerry said. "But Small was killed instantly, and Schwartz didn't regain consciousness, so neither could say anything."

Gus handed back the clippings and the penciled warning. "What was the date of the first wreck?" he asked.

"January 7th," Jerry told him. "The second was on the 29th." He wound his muffler around his neck. "You're lucky, working in a warm place. Believe me, riding a motorcycle last night was a cruel job . . . I'll escort the wrecker in."

Gus stared unseeingly at the shop door after it had closed behind Jerry. "It *was* cold last night," he said musingly. "It *could* be that . . . worth checking, anyway."

He went into the office and called Dr. Marvin. "Doc," he asked, "are you still playing with weather forecasting?"

Doc laughed. "I still keep an eye on it. Why?"

"Which night was the coldest so far this winter?" Gus asked.

"That's easy," Doc told him. "January 29th—five below zero at midnight."

"How about that night toward the beginning of the month?" Gus persisted.

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Murder to the Punch

"It was cold then, too," Doc assented. "On January 7th it was one above—just a little colder than it was last night."

"Thanks," Gus said. "How cold is it going to get tonight?"

"I'll bet you a real good cigar," Doc said, "that it's below zero by midnight."

EARLY that afternoon Jerry Corcoran came into the Model Garage shop with a man who had one arm in a sling and his face decorated with bandages and surgical tape.

"Hard luck, Fred," Gus said consolingly. "It's nothing serious, I hope."

Gaskell grinned crookedly. "Nothing I won't get over. Lucky it wasn't my bowling arm."

"How did it happen?" Gus asked.

"According to all the evidence, I went to sleep at a curve," Gaskell admitted sheepishly. "It was so cold I had the windows closed, and I remember feeling drowsy and thinking that I ought to open one. The next thing I remember the truck was in a ditch."

"Truck outside?" Gus asked. "I'll look at it. Make yourself comfortable, Fred."

Gus examined the front end carefully. Then he got into the cab. After a minute he climbed out, raised the hood, and examined the engine briefly.

Back in the shop he faced Jerry and Gaskell. "I've found out how your trucks were wrecked," he said. "But that's only part of the job. We want to catch the man who murdered Small and Schwartz—catch him red-handed, and send him where he can't do any more damage. We can do that tonight, if you two will help."

"It's O.K. with me," Gaskell said.

"I'm taking your orders," Jerry assented.

"Good!" Gus said. "Now, Fred, when are your trucks serviced, and when do they leave on their night trip?"

"They're serviced in the afternoon," Gaskell told him, "and they leave as soon as they're loaded—about seven o'clock. The drivers don't try to keep together. There'll be six tonight."

"Good enough," Gus said. "Fix it so I

Jerry was out the other side of the cab. In a few quick strides he caught up with the fleeing man

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can go over them for 10 minutes while no one else is in your garage."

One of the plant guards was waiting for Gus and Jerry when they came to a stop at the gate of the Victory Manufacturing Company. "I'll take you to the garage, Mr. Wilson," he reported.

"Thanks," Gus told him. He turned to Jerry. "Hook yourself onto Smith when he comes out, and when he changes trucks get in with him."

Jerry nodded. Gus followed the guard to the garage and left him at the door. He lifted the hood of each truck, examined the engine quickly, and made some notes.

The trucks were loaded in a courtyard. Gus swung his arms and stamped his feet through a frigid 10 minutes. Then Gaskell and Jerry appeared with a group of drivers who looked worried. "Get your trucks and load up," Gaskell told them.

They went off toward the garage. Jerry was following a short, thin, middle-aged man with a sullen face. "That's Smith," Gaskell pointed out. "He drives No. 4."

Gus consulted his notes. "After they all have backed to the loading platform," he ordered, "tell Smith to change to No. 2."

Gaskell nodded. He walked down the line as the trucks were backed to the platform and swiftly filled with heavy cases. "Smith!" he called. "Take Bill Henty's truck tonight . . . Henty! Drive Smith's."

Smith seemed about to protest, but he evidently thought better of it. He got out of his truck and into Henty's. Jerry climbed in at the opposite side. "You don't mind me riding a way with you, do you?" he asked.

The driver glowered, but he didn't protest. Then Gus climbed in at the left and crowded behind the wheel. "I'm going to drive awhile," he explained.

He drove out of the yard and down the highway. Both cab windows were open. Gus closed his. "Shut your window, Jerry," he said. "We don't want to catch cold."

"Better leave them part-way open," Smith growled. "It gets stuffy if you don't, and we're apt to get sleepy."

Gus laughed genially. "Why, man," he said, "it's close to zero and getting colder."

They drove on and on. Two hours passed. As they neared a roadside tavern, Smith broke his silence. "Stop for coffee," he demanded. "I've got to have a cup to keep me awake."

But Gus drove on. "You don't need to keep awake," he told him. "I'm driving."

They went on for another hour. Gus's head was aching, and Jerry's stomach wasn't feeling right. Smith, who had slumped forward in his seat, straightened up with an effort. "I gotta have air!" he muttered. "Open a window. Lemme outa here!"

"Small and Schwartz had to have air, too—but they didn't get it," Gus said sternly. "What's the matter—are you afraid?"

He felt the little man start. "Open a window, mister," Smith whined. "We'll all be dead if you don't. This cab's full of carbon monoxide!"

"Now you're imagining things," Gus told him. "Where would carbon monoxide come from?"

"The exhaust fumes are coming up through the floor boards," Smith gasped. "The exhaust manifold is loose."

"How do you know that?" Jerry asked.

"I know it because I loosened the nuts," Smith yelled. "Lemme outa here!"

The lids were dropping over Gus's eyes, and the road was weaving crazily in the beam of the headlights. He tried to open his window, but his fingers fumbled helplessly. Then there was a shattering of glass, and cold, fresh air rushed into the cab.

Gus gulped in lungfuls of it, stopped the truck, and swung out onto the running board. Jerry had his revolver in his hand—he had smashed the window with its butt.

Smith straightened up, and made a dive past Gus through the open door. Jerry was out of his side in a flash, his clubbed revolved still in his hand. He caught Smith in a few quick strides, and hauled him back.

THE next afternoon Trooper Jerry Corcoran came jauntily into Gus's shop. "A full, signed confession," he reported. "That Nazi is where he'll do no more harm. But say, how did you figure it out anyway?"

"You gave me the idea when you grouched about how cold it was the night Gaskell had his wreck," Gus laughed. "When I checked, I found that Small and Schwartz had also run off the road on cold nights when they probably had their windows closed. That made it likely that something had put them to sleep or made them unconscious. Carbon monoxide was the only thing I could think of that would do it.

"When I examined the truck Gaskell ditched, I saw that some of the nuts on the exhaust manifold had been loosened with a wrench—there were fresh marks on them—and that the floor boards of the cab had obviously been loosened. Then when I checked the trucks at the Victory garage I found one had been tampered with.

"Making Smith ride in that truck with us," he went on, "seemed the surest way of getting a confession. But I didn't mean to run it so close."

"I'll say you ran it close!" Jerry whistled. "But it was nice work, Gus. You ought to be on the force. There's a G-man big shot due in a few minutes to give you official thanks. You'd better put on a clean shirt!"

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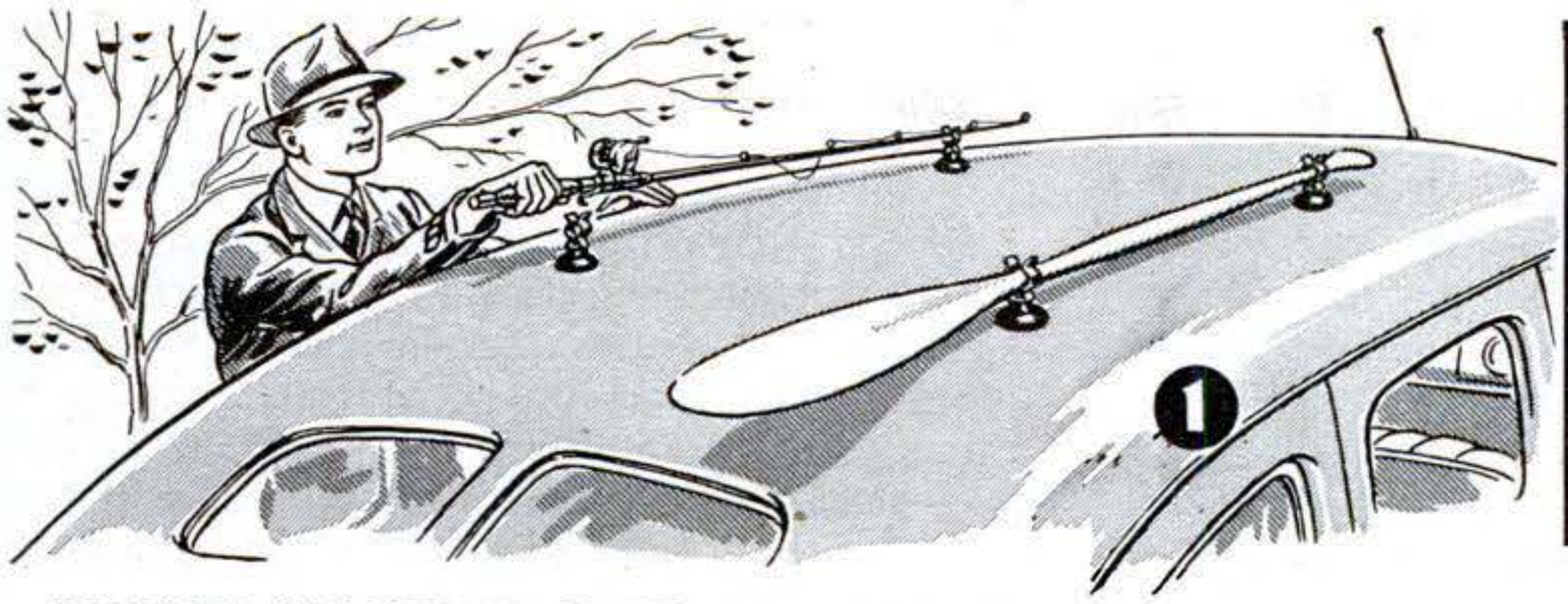
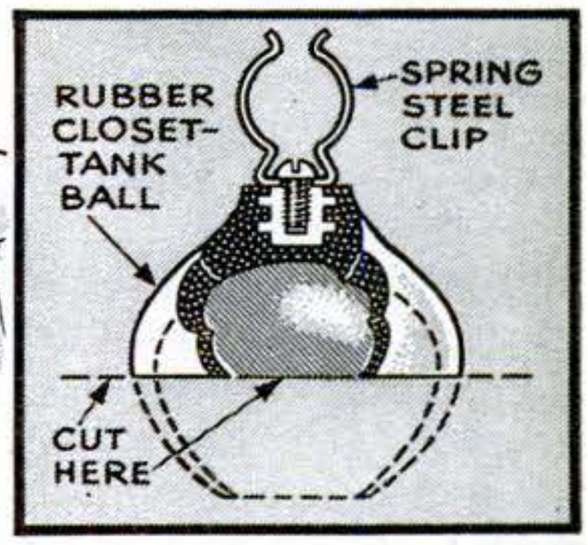
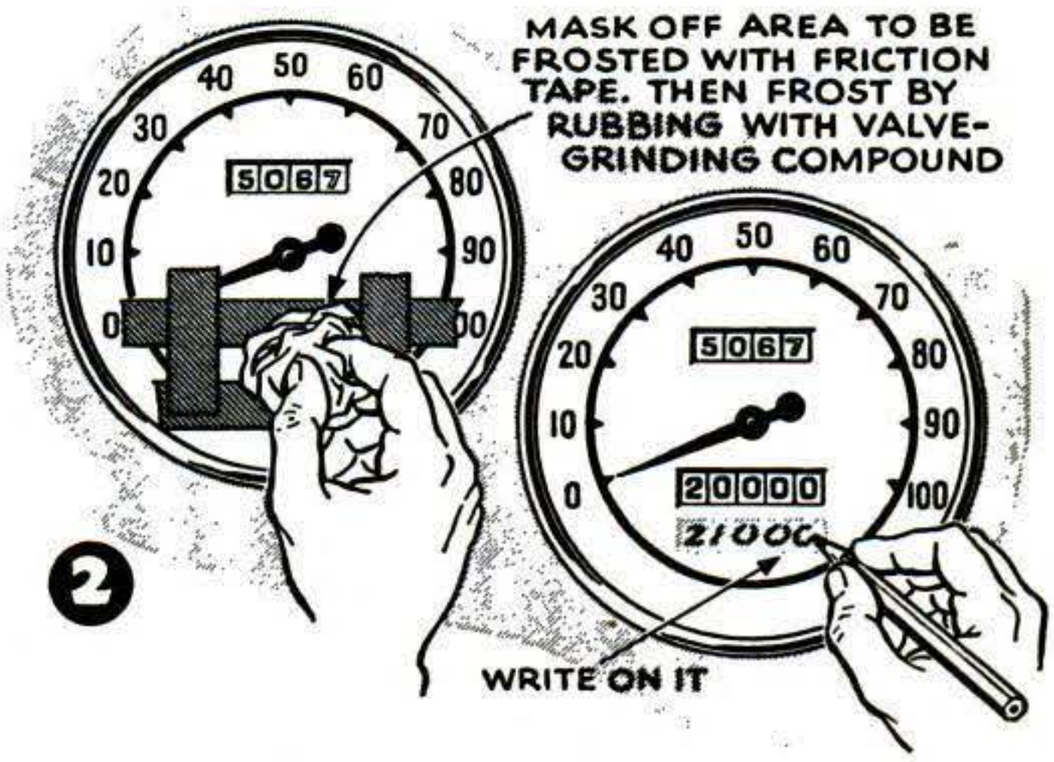
USEFUL AUTO HINTS

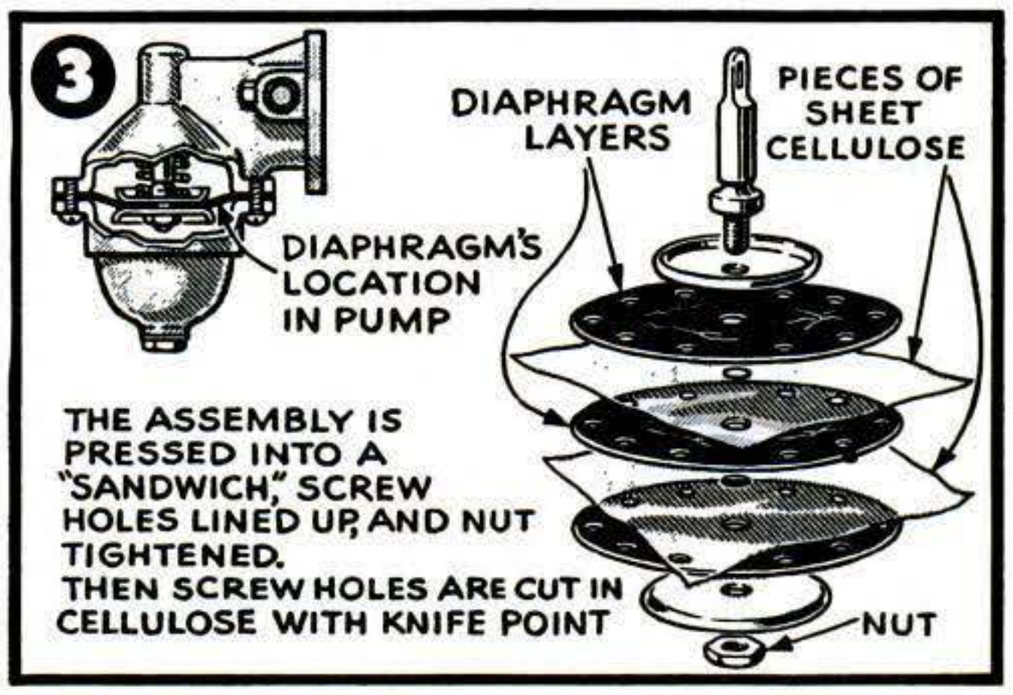




1 RUBBER VACUUM CUPS with strength enough to hold light articles on top of your car can be made from discarded flush balls that your plumber may be glad to save for you. There should be no puncture in the upper part. Cut off the balls about ⅛″ below the halfway mark and face the edge on a rough emery wheel. Affix a spring clip to each threaded top.—J. E. W.



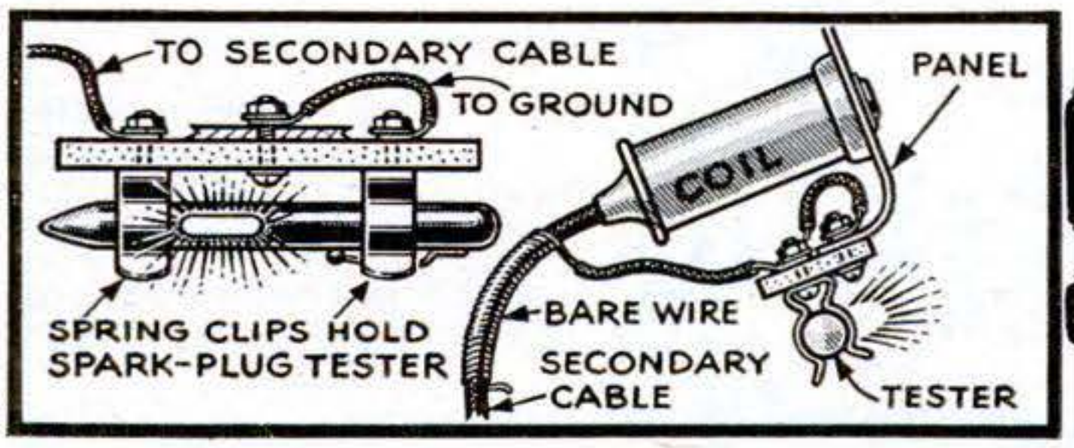
2 FOR A CONSTANT REMINDER of when to change oil or rotate tires, frost a strip on the speedometer glass to take penciled memoranda, which can be erased or washed off when desired. One way to frost the glass is to mask an area with tape and rub with valve-grinding compound.—R. H. D.



3 EMERGENCY REPAIR to a fuel-pump diaphragm is possible with the transparent cellulose wrappings from a candy bar, loaf of bread, or the like. Sandwich a sheet between each two adjoining diaphragm layers, trim the edges, and punch screw holes; then replace the assembly.—F. W. D.

4 CHECKING ON SPARK PLUGS is continuous with an electrically wired holder for a neon-type tester mounted within sight under the dashboard. Remove 12″ of insulation from a length of wire, wrap it around the secondary cable, tape it over, and connect the other end of the wire to one holding clip. Ground the other terminal. Make the base of some insulating material. The tester will light by induction.—A. H. P.

Drawings by STEWART ROUSE



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Teach Your Car to

IF YOUR ENGINE BALKS AT THE COLD, THESE

By TOM McCAHILL

THERE is hardly a driver who doesn't know that he should change to light lubricants in bitter weather, and that he should watch the strength of his antifreeze. Most, too, make winter checks on the automatic choke and seasonal carburetor setting, if they have that equipment, and on thermostats and the generator regulator.

But there are some other less obvious points to watch if you would really have your car operate at peak efficiency during the cold months. For instance, most owners know that an engine becomes stiff in cold weather, making starting hard. They also know that a run-down battery can't furnish the current necessary to turn a starting motor quickly. But couple a stiff engine with a battery that isn't fully charged and you will let yourself in for some real headaches.

In turning a stiff engine, the battery carries a load far greater than normal. This overload deprives the high-tension circuit, which draws on the battery at the same time, of part of its required voltage, and as a consequence weakens the spark at the plugs. Then, too, the mixture from the carburetor will be cold and harder to ignite. In short, you may have a stiff engine, an overloaded, low battery, a weak spark, and a cold mixture. No wonder some cars are hard to start in winter!

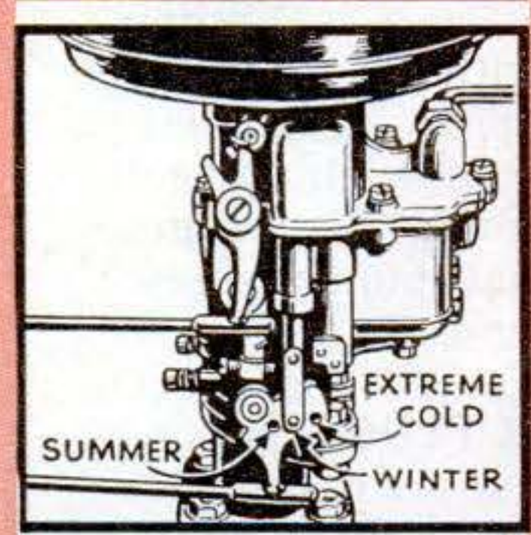
These conditions can't be eliminated entirely in freezing temperatures, but they can be eased. If you have checked your generator regulator and have started the winter with a fully charged battery, you will have helped some. But also check the ignition system, including the points, spark plugs, and connections. A slight electrical leak that might pass unnoticed in warm, dry weather can cause starting trouble on a cold, damp day when condensation may provide a perfect ground.

Inspect the inside of the distributor cap and the high-tension wires for possible leaks or breaks if starting trouble develops. As an emergency measure in an extreme case where an abnormal amount of moisture is present from snow or a driving rain, you might try spraying the contents of a carbon-tetrachloride fire extinguisher over the electrical circuit from starting motor to spark plugs. The carbon tetrachloride will dry so quickly that it will absorb the moisture and you will be able to start the motor. But this is only an extreme measure and shouldn't be resorted to except in an emergency, for the chemical is rather hard on the wiring and on lubricated parts it may touch.

For a cold-weather starting stunt that may work on your car, try widening the

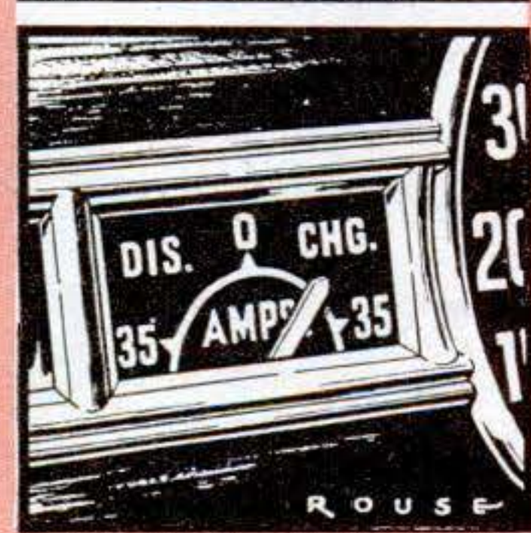
DO'S

Give your car a break and break the "cold seal" when the mercury is low. Before you try to start up, rock it in high gear with the switch off until the motor turns over. This saves the battery a terrific strain



Be sure that the seasonal settings are adjusted if your carburetor has them. If your car doesn't have this adjustment, set the carburetor manually for a somewhat richer mixture

Always step on the clutch before you press down the starter button, and you'll save your starter motor the heavy load of turning the transmission gears



Watch the indicator on the dashboard to see that your battery is receiving its proper charge. Check also on the generator regulator if the output seems too low

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Laugh at Winter

POINTS MAY SAVE TIME, TROUBLE, AND TEMPER

spark gaps to present a longer flame to the cold mixture. Most factory-set gaps are .020″ to .025″, but you may find that you can widen yours a trifle for cold weather, even as much as another .010″ to .015″. Of course, you must have a fully charged battery or you won't have the voltage to back these gaps.

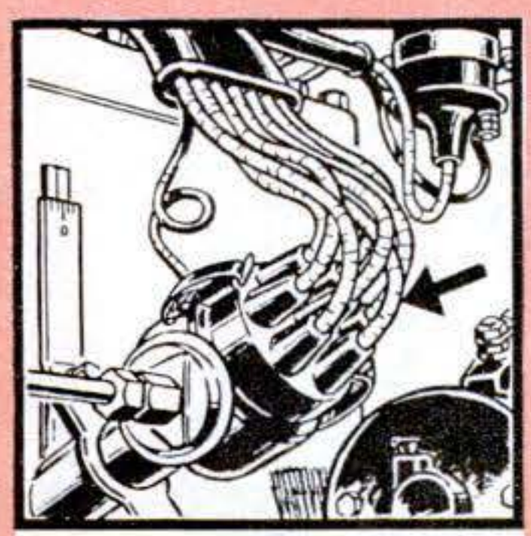
Incorrect handling of the throttle, such as opening it wide before the engine fires, can contribute to balky starting since it leans the mixture by increasing the air entering the carburetor. The only time to open the throttle wide when starting is after the carburetor has flooded and the cylinders have been filled with raw gas. Opening the throttle then cleans out the raw gas after a few turns of the engine.

When a car has remained unused for some time in cold weather, the engine becomes very stiff, and what is known as "cold seal" often develops. The oil in the crankcase congeals and many parts of the engine tighten up. To avoid subjecting the battery to the terrific extra strain required to turn an engine in this condition, break the cold seal by rocking the car in high gear before starting the motor. Keep the switch turned off and rock the car back and forth until you feel the engine turn.

Condensation is always a danger to an engine in winter. You can't avoid condensation, for it is caused by heat inside the engine and cold outside, but you can lessen its bad effects by letting your engine warm up thoroughly every time you start it. Condensation may vary from a few drops to as much as a pint, depending on the contrast between heat and cold. If the engine isn't allowed to warm up thoroughly so this inside condensation will be carried off, water dripping from the interior walls will make its way into the crankcase oil, diluting it and creating sludge. Then this contaminated oil will be unable to provide the necessary protective film the next time the engine is run. Knowing this, you will be wise to avoid short runs, such as from the curb outside your house into your garage, and to walk to the drug store and the movies if they are just down the block.

A stunt that will speed the warming up of an engine is removal of the cooling fans in climates where the winter temperature rarely rises as high as 65 deg. Operation of the fans in freezing weather can keep radiator temperature as low as 140 deg., reducing the efficiency of an engine that for peak performance requires a radiator temperature of 160 to 180 deg. Remember, though, if you are using alcohol or some other antifreeze with a low boiling

DON'TS



Letting cracks and breaks in high-tension wires go without attention may rob your ignition system of needed voltage. Leaks may be caused by grounds that result from condensation, dampness, or driving snow

If you open your throttle wide before the engine has a chance to fire, the lean mixture will make starting hard. But if the carburetor floods with raw gasoline, then open the throttle wide

Bumps that hardly jolt you in mild weather can badly damage springs, axles, and frame if the metal is cold and brittle. Take it easy until your car loosens up

Never leave your car just outside the garage during a freeze. When you drive in later, the engine won't warm up sufficiently, and condensation will result

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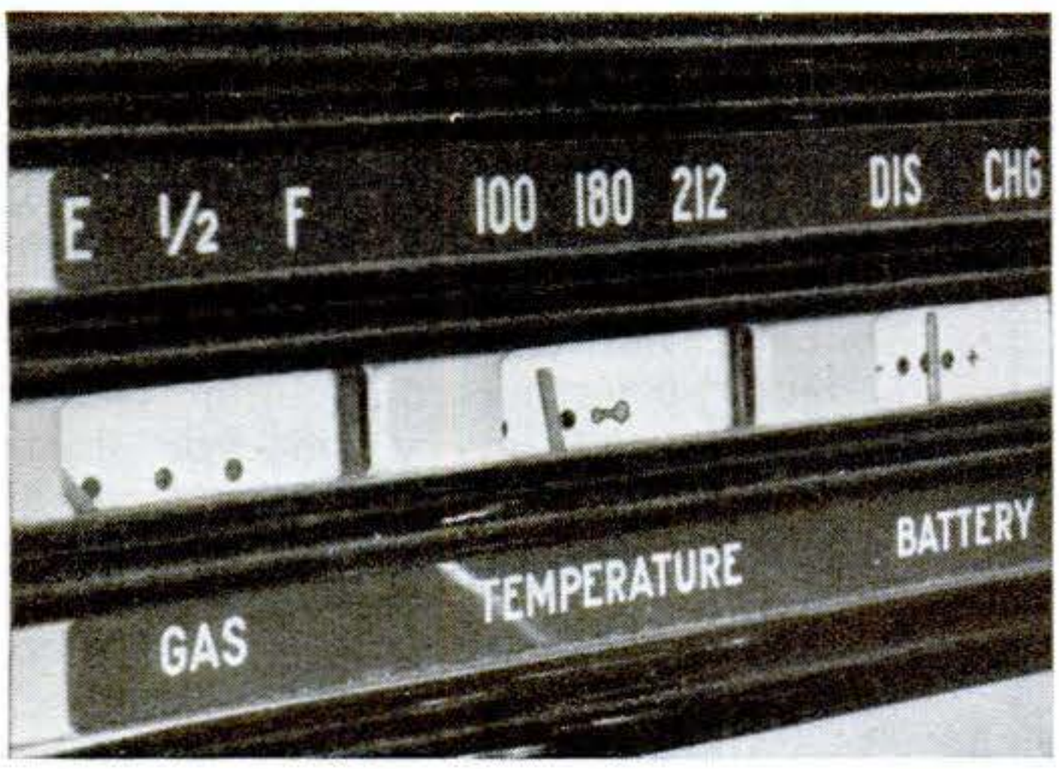
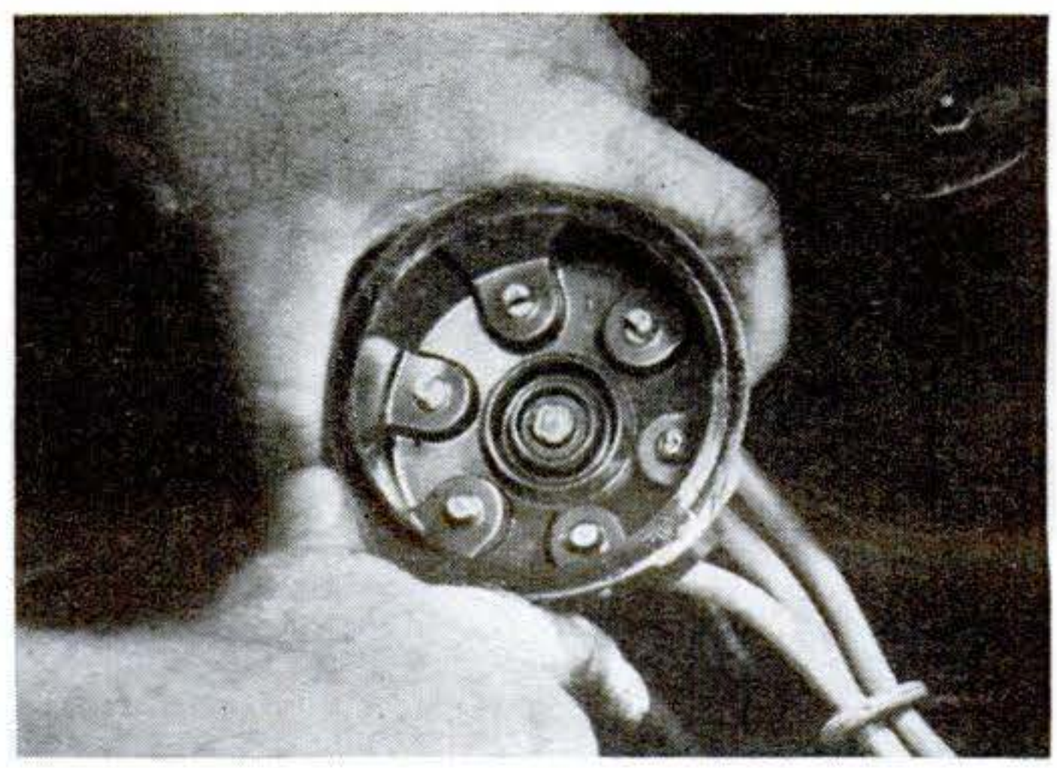
Properly firing spark plugs are a necessity when the mixture is cold. See that the gaps are set right, the points cleaned, and the porcelain sound

Battery care is a "must" in cold weather. Check terminal connections, scrape off all corrosion, and be sure that the cells are kept well charged

Your engine usually performs at its peak when its temperature is from 160 to 180 deg., but don't let it get too hot if your antifreeze boils easily



If starting trouble develops, take a look at your distributor cap. A crack in it may result in a ground when condensation is bad in cold weather



point, you run the risk of having it evaporate and leave you without antifreeze protection. You should also be sure that your cooling system is free from scale and rust and in top shape, or boiling will be a certainty and any gain in performance may be at the cost of some other serious trouble.

The fan blades are usually attached to the fan hub by four studs that can be easily removed or replaced when desired. Take them off if you decide to dispense with the fan in cold weather. Don't remove the fan belt, for in many cars this belt also turns the generator and the water pump.

Perhaps the least known of all winter hazards is condensation in the fuel pump. If the condensate freezes inside the pump housing and around the diaphragm, ice particles may prevent proper operation of the diaphragm with the result that the engine is deprived of its normal flow of gas and speed and power are reduced. In extreme cases the diaphragm may even be punctured by ice, causing a complete breakdown. Make sure that both the drain and the vent holes are kept clear. This is the easiest way to prevent accumulation of condensation.

Many cars are equipped with heavy-duty rubber parts, such as engine supports and shackle fittings, and in cold weather the rubber tends to lose flexibility. You can keep these parts from becoming too brittle by spraying them occasionally with regular hydraulic-brake fluid. Don't spray rubber with oil, however, for oil causes most kinds of rubber to deteriorate.

The metal of springs, axles, and chassis also becomes stiff after exposure to cold and is unable to stand the ordinary bumps and jolts that it will take without bad effect in warm weather. That depression where your driveway joins the street should be eased over with respect when the temperature drops. If it isn't, you may wind up with several cracked leaves in your springs or with a fracture in an axle or even the frame. It is a wise precaution to take it easy when you start off on a cold day—let the running gear loosen up by driving at a moderate pace for the first mile or two.

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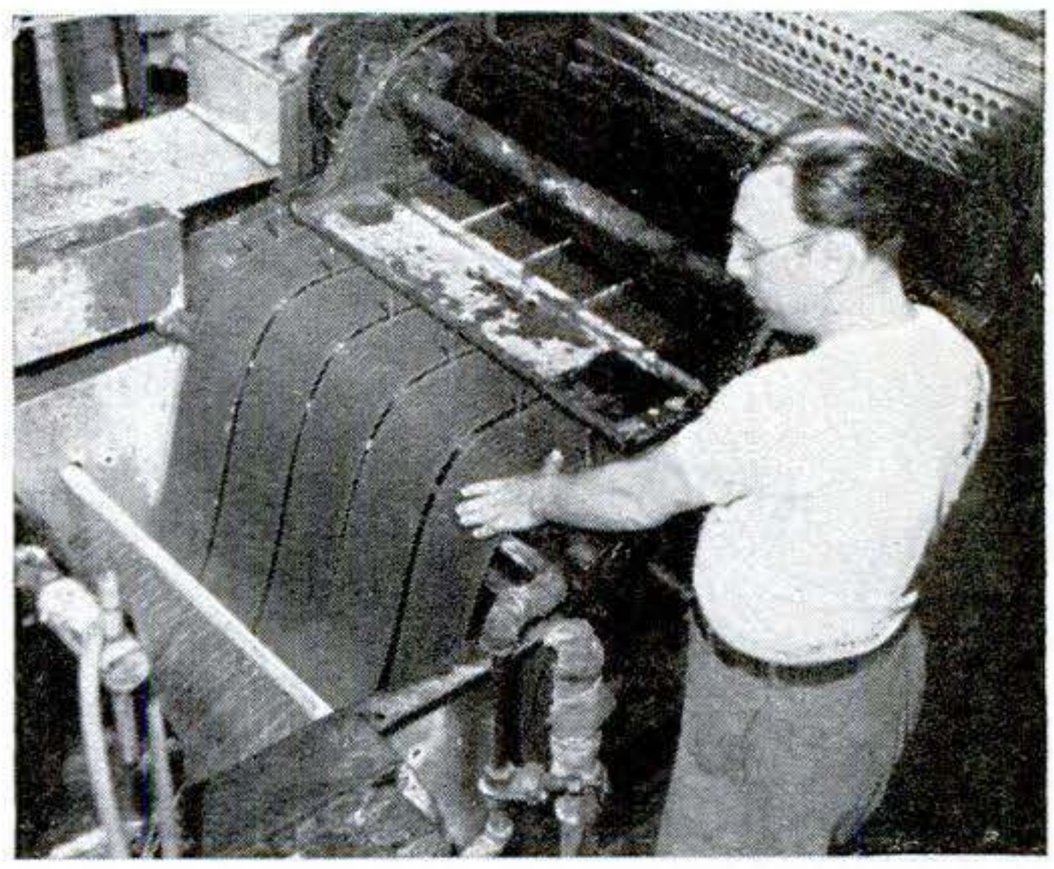
AUTO *Ideas*

THIS MIDGET THREE-WHEELER is the postwar-car idea of Robert H. Verkins, of Minneapolis, and his son, Wayne, now in the Army. It was designed and built entirely in Verkins' home workshop with the exception of wheels, headlights, and tires. Among its features are two 1-hp. engines with dual ignition and carburetion, bicycle-handlebar steering, upholstered spring seats, and a complete line of gadgets. It gets 65 miles to the gallon of gas and will do 32 m.p.h. The weight is 250 lb.

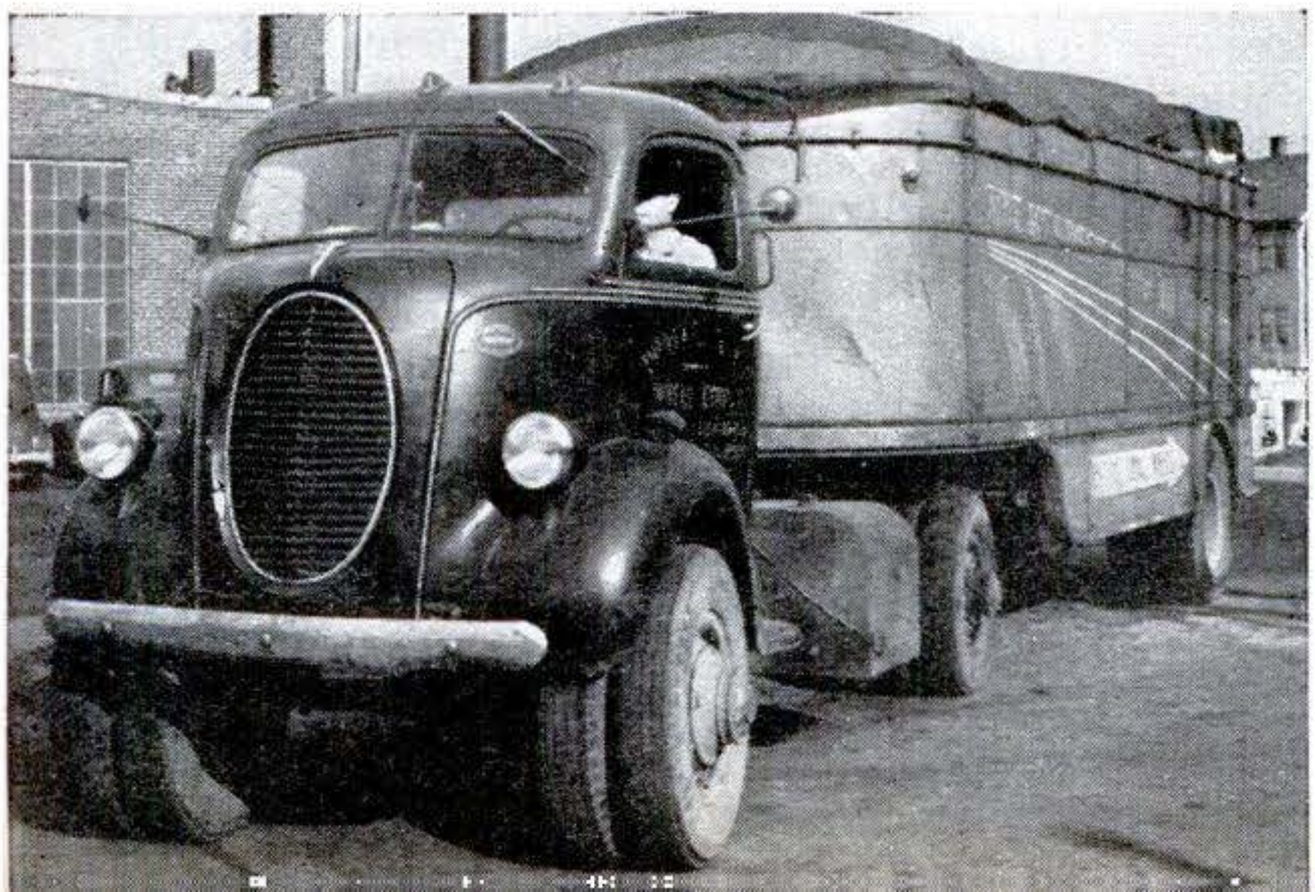
INCREASED VISIBILITY is given license plates by new-style numerals designed by Dr. Curt Berger, of Cornell University. Width of lines is decreased, and white numerals are put on a black background having a narrow white border.

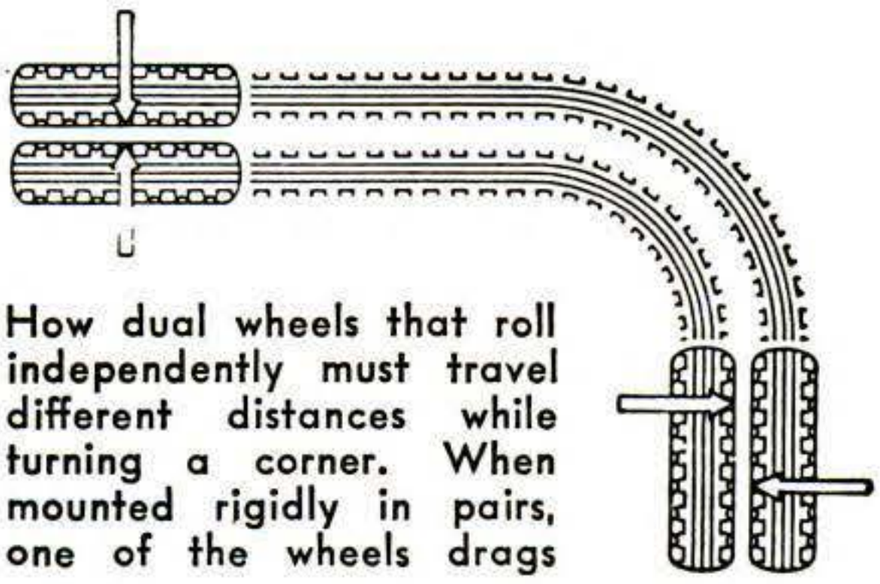
BATTERY SEPARATORS of thin "microporous" rubber have been developed for the armed services by the United States Rubber Company. Storage batteries containing them are initially charged; then the acid mixture is removed, plates and separators are dried, and batteries are shipped fully charged without acid and water, which are added again after delivery. A step in the manufacture of the separators is shown below.



DUAL WHEELS, which have long been made for truck rear axles, have now been developed for front axles as well. This application is made possible by a new design that gives each wheel of a pair independent operation. It will be ready for postwar buses, heavy trucks, and the like. The design can be accommodated both to demountable rims and to demountable wheels, and in both cases inflated tires can be removed and replaced.

As indicated in the drawing, the unlocking of dual wheels so that the tires can roll independently is of particular importance in saving tire wear on crowned roads and in turning corners. Where dual wheels are employed without this feature, the tendency is for one wheel to drag the other, the inner tire wearing particularly where it takes extra weight or is abraded by drag. The wear is similar to that on badly underinflated tires or those on wheels that are out of alignment. Independent rolling, however, permits the outside wheel to travel a greater distance than the inner and prevents drag. The new development is the work of engineers of the Differential Wheel Corporation, of Detroit.





How dual wheels that roll independently must travel different distances while turning a corner. When mounted rigidly in pairs, one of the wheels drags

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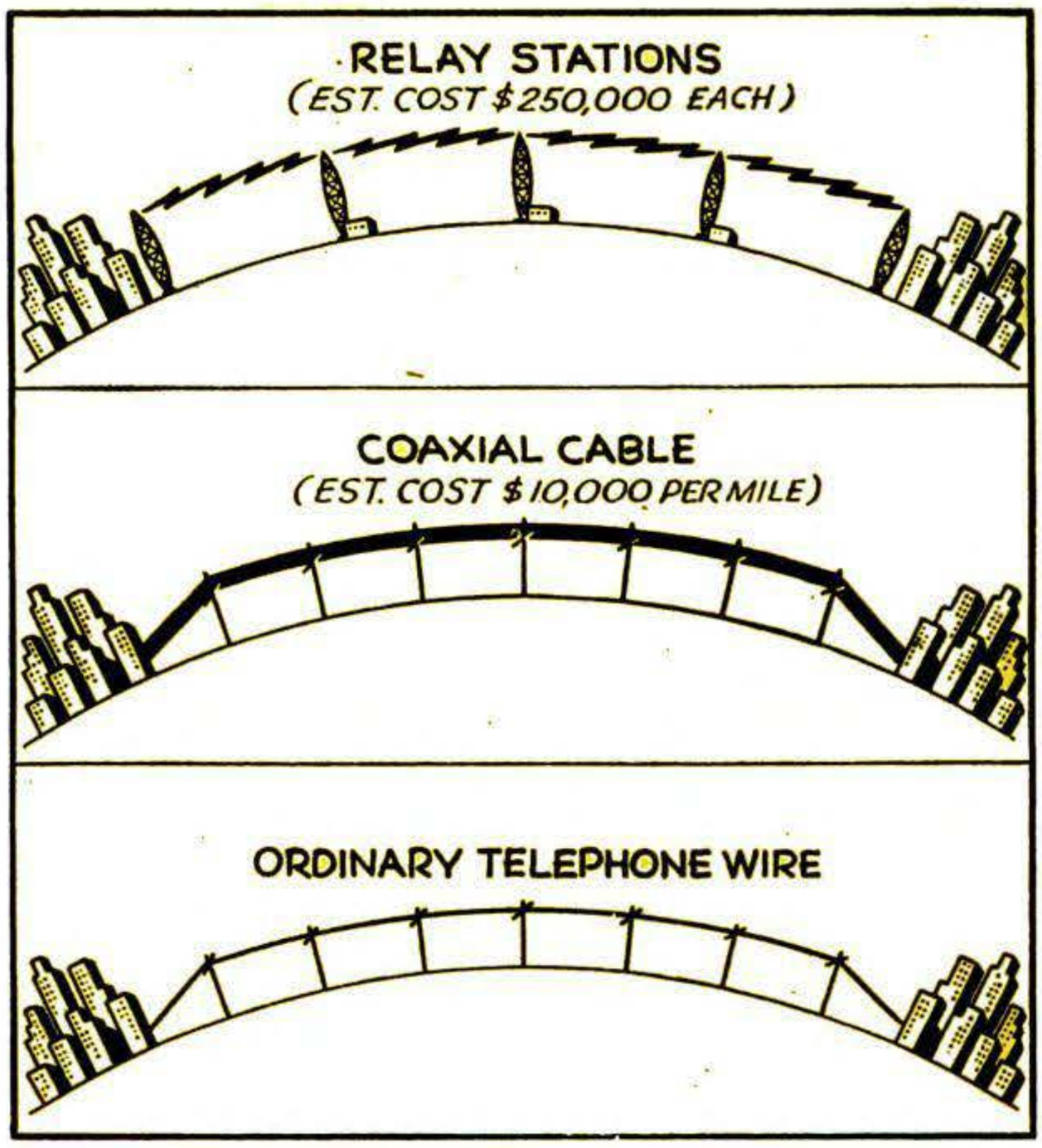
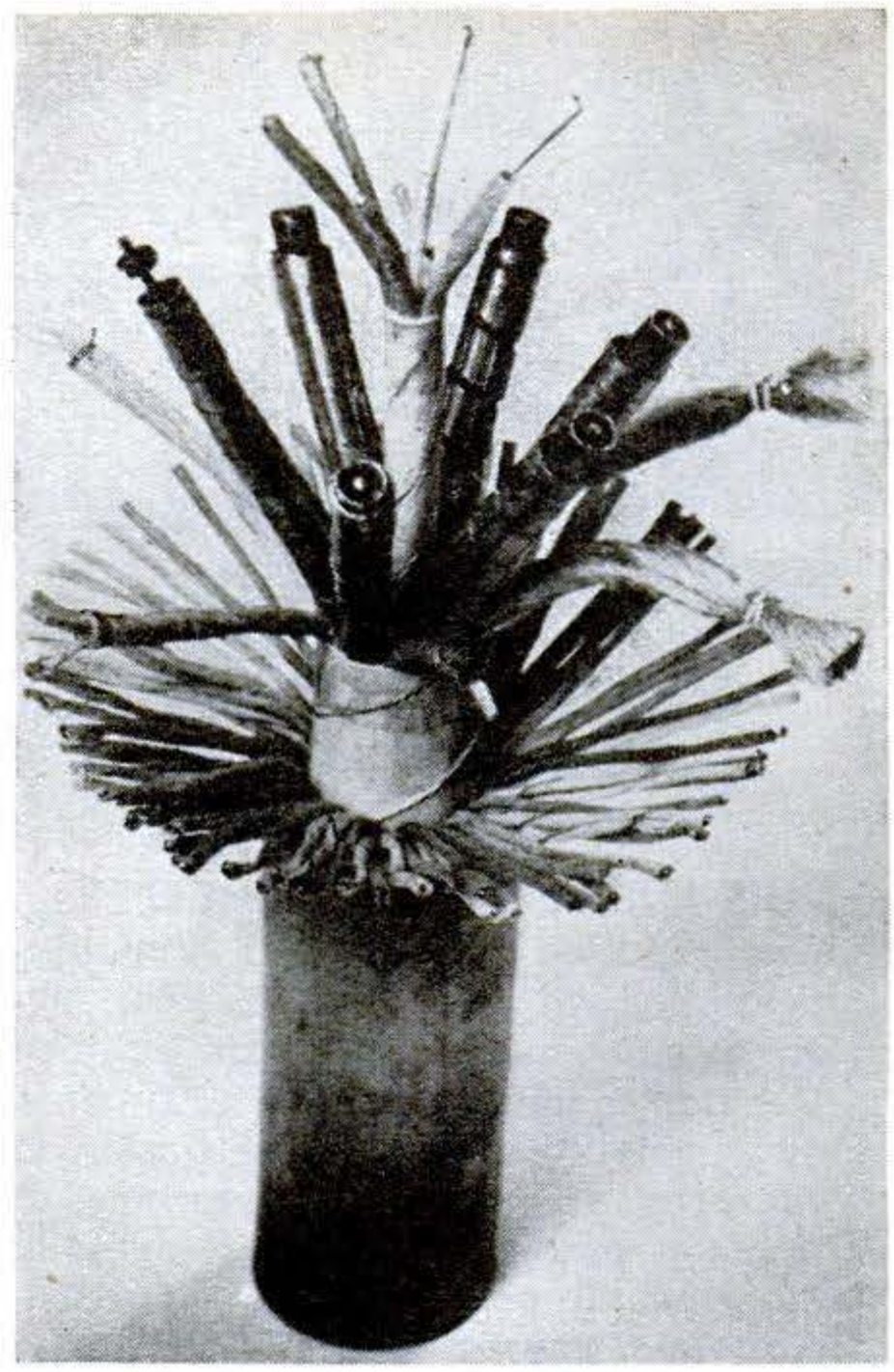
TELEVISION NETWORKS MAY USE ORDINARY PHONE WIRE





Until now the range of television could be extended only by relay stations that were close to each other, or by the use of expensive coaxial cable, shown above. Transmission by ordinary telephone wire is believed possible with new circuits, thus making network television a reality

NEW circuits said to afford recordings of television programs and also to make network hookups possible over common telephone lines may speed the day of sight-and-sound programs on a scale comparable to radio.

Because the extremely short waves used for television transmission travel in straight lines much like light, their range extends only to the horizon, about 30 miles in the case of most transmitters. To cover greater distance, two or more transmitters have had to be linked either by a series of costly relay stations 30 miles apart, or by a coaxial cable such as is used in long-distance telephony. While relocation of the television spectrum among the longer wavelengths might extend the range of transmission (just how much is not known) the broadcast bands are already so crowded that this is a doubtful solution.

That transmission over phone wire isn't impossible was shown in 1939 when television signals from Madison Square Garden in New York were successfully transmitted over ordinary telephone cables to the N.B.C. studio at Radio City, a distance of less than a mile. Special measurements and alterations had to be made on the cable before use, however, and signal loss was about 1,000,000 times that over the same length of coaxial cable. The conclusion was that ordinary lines could not be used except for very short distances.

The new circuits, developed by Raymond Binney for the Packard Manufacturing Corporation, require changes in the receiver but none in the camera or the cable. According to Homer E. Capehart, president of the company, they promise to make coast-to-coast hookups available at no greater cost than that of equivalent radio networks. In a demonstration, television signals were sent over 12 miles of telephone line and a shorter coaxial cable with no appreciable difference in quality. The line was wrapped about electric motors and other devices that ordinarily cause video distortion, but it is said no interference was apparent.

Mr. Capehart also announced that the new circuits make possible the recording of television signals on wax records. This requires impressions of 500,000 cycles per second or more, but the company's researchers are confident that up to 1,000,000 cycles will eventually be recorded.

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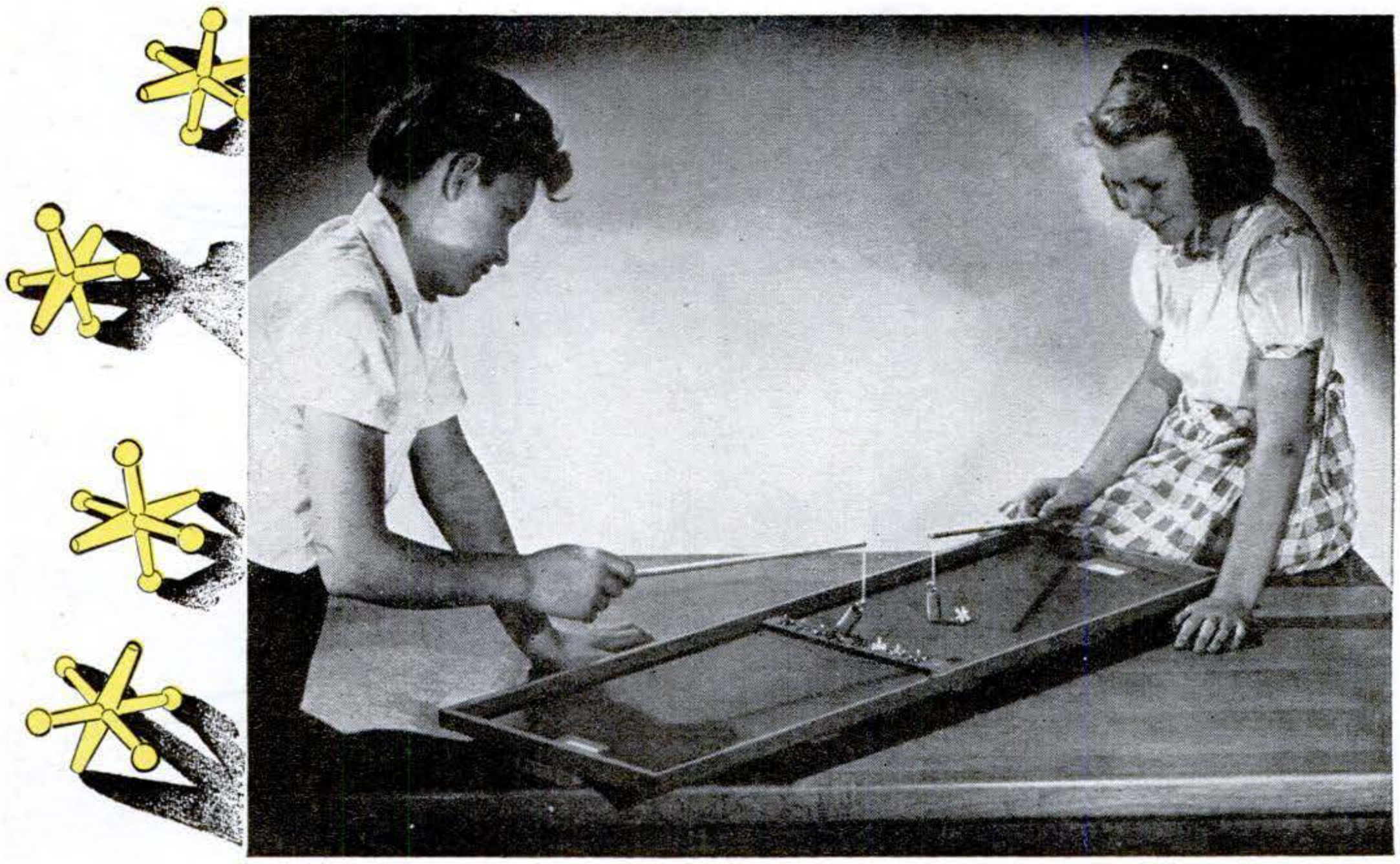
FAST JACKSTONE GAME USES SWINGING BATS



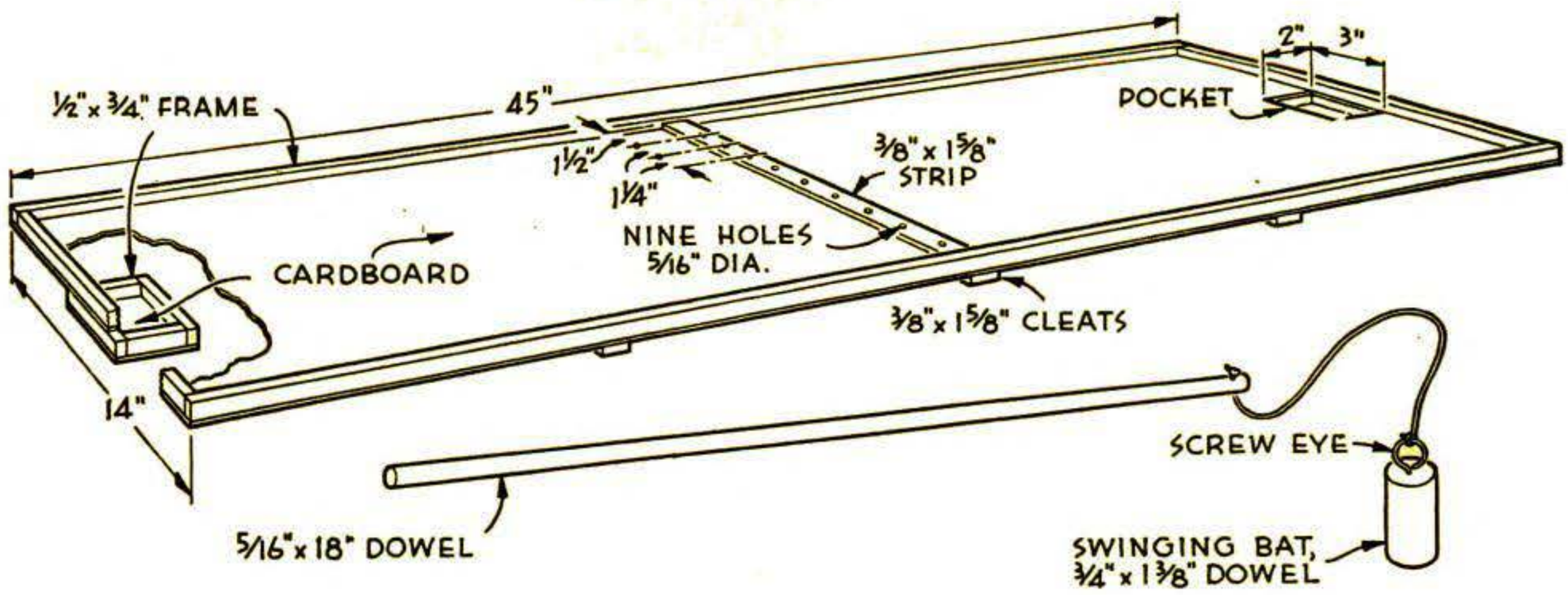
By MYRON FLEISHMAN

FOR a fast, modern version of an ancient game, make a board and two pendulum-swinging bats to use with jackstones. Then pit yourself against an opponent and, at the word "go," start batting jackstones toward the pocket at your end of the board. It is a game that will provide amusement for grown-ups as well as for children.

Build a simple 14" by 45" frame with butt joints, as shown in the drawing, and tack cardboard to the bottom. Two sheets of cardboard may be used if one 45" in length is not at hand, for the joint at the center will be covered by the starting strip and will not interfere with play. This strip is bored with nine holes to take the nine jackstones required for a game.

Pockets at the ends of the board are also simple butt-jointed frames glued to the bottom of the cardboard which has, of course, been cut out to provide the necessary openings. Cleats of the same depth as the pockets make firm supports.

Each bat is made with a short dowel suspended by a cord from another dowel that serves as a handle. With some practice this can be swung so that the short dowel can be controlled in batting jackstones toward your pocket. Play until all jackstones are in pockets, contesting possession of any you wish. Count one point for each pocketed jackstone and play three sets for a complete game.



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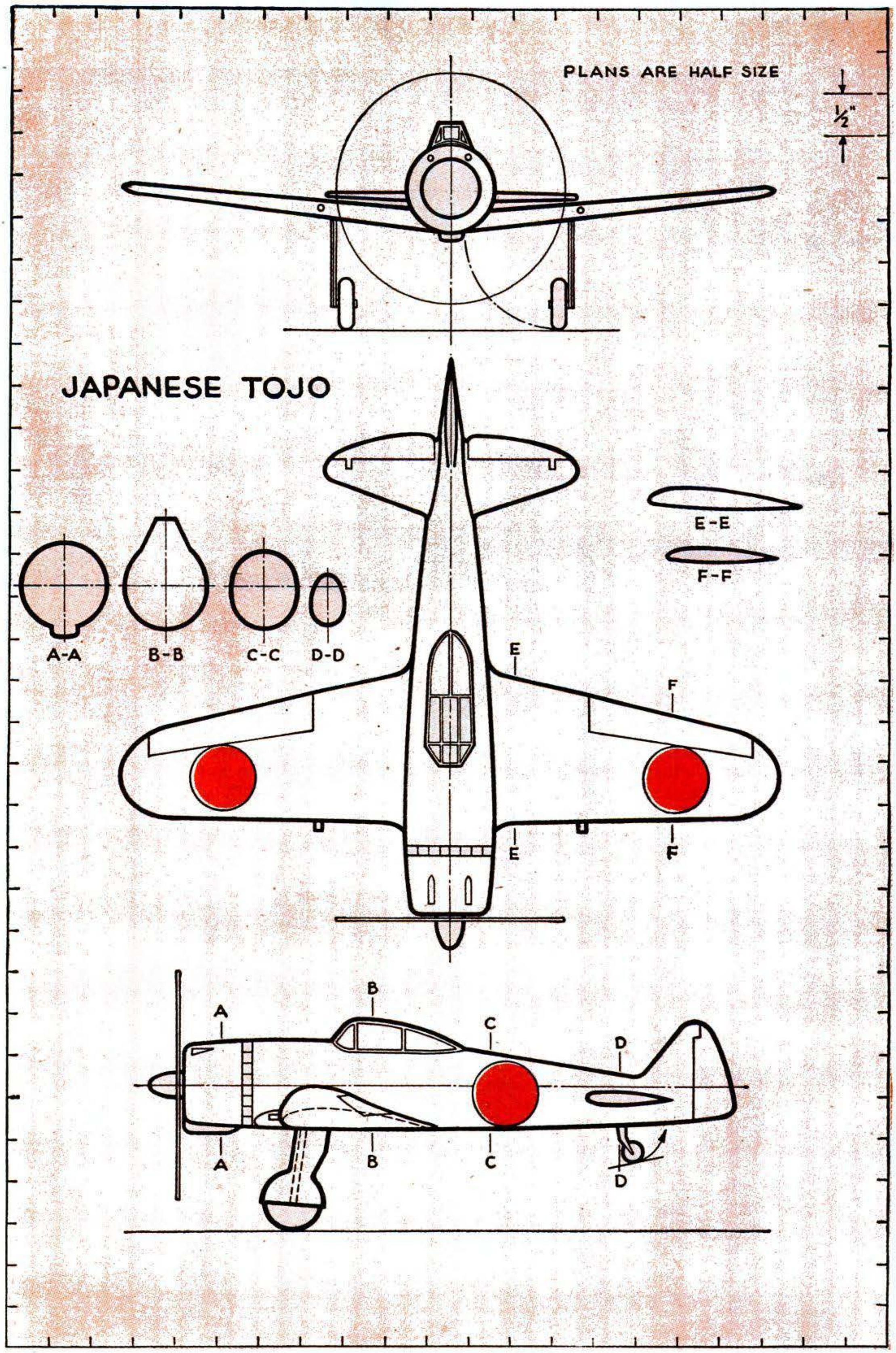

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RECOGNITION MODEL OF THE TOJO

Building in Miniature One of the Newest Japanese Fighters

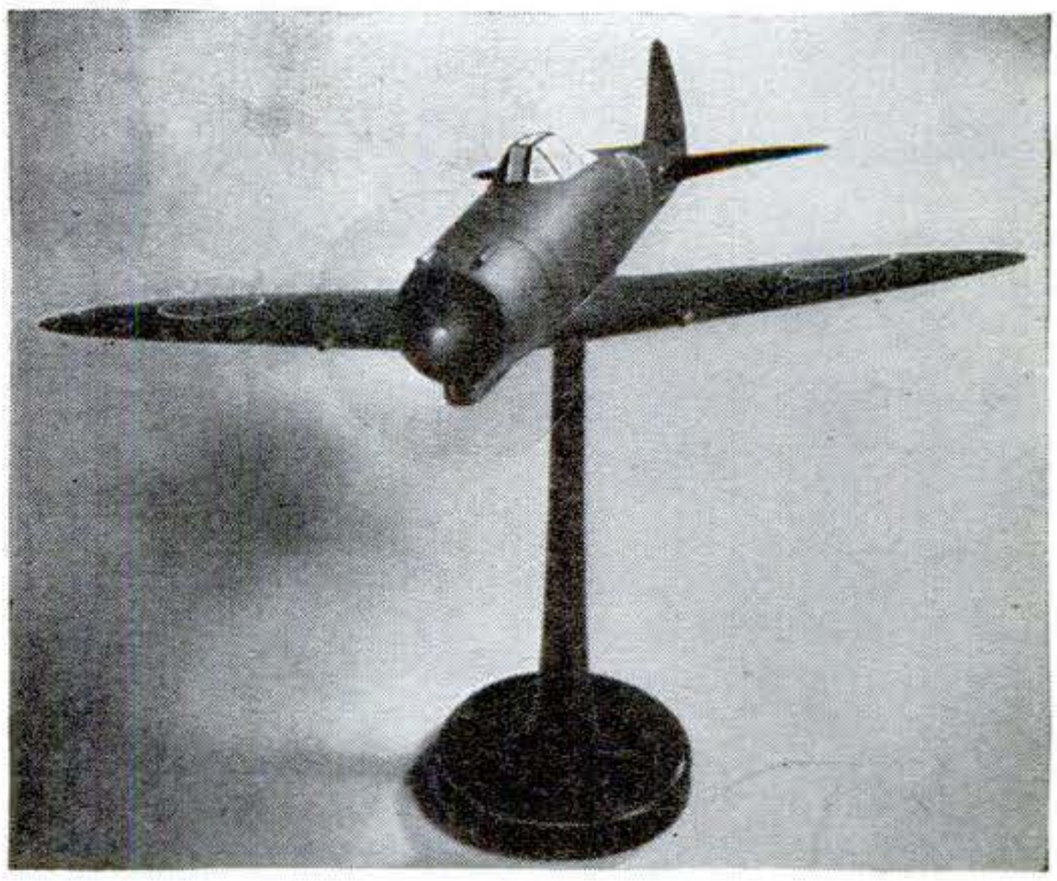
THE Jap makes a poor combat pilot. He is inclined to lose his nerve. Sometimes this causes him to stall his plane so it sits for precious moments at the mercy of his adversary. At other times he refuses to come to grips with the enemy, preferring to stay out of range and spray the sky with his ammunition until it is expended, and then high-tailing for home. But—although you would never guess it from the box scores—he doesn't build bad aircraft. His fighter planes are held in high esteem by our airmen. For example, one of the latest Nipponese fighters—the single-seater, single-engined Tojo—has a top speed of about 380 m.p.h. and a formidable array of armament. With a wing span of only 31½′, it is a watch charm of a plane. It resembles Germany's well-known Focke-Wulf 190. Unlike the early Zeros, it is well armored, ensuring protection for the pilot. The radial engine, a Nakajima Type 2, develops 1,400 hp.

The model is built of wood, preferably balsa or white pine. Lay out the fuselage profile on a block that measures 1¼″ by 1½″ by 7″; then cut away the excess wood. Draw the plan view on the block and again cut away the excess material. Carve a notch in the bottom for the wing and another farther back for the stabilizer. Shape the blank to agree with the accompanying fuselage sections and sand it to a smooth finish.

Make the wing from ¼″ by 2″ stock. Cut it to the shape shown in the plan view; taper it toward the tips as indicated in the front elevation; then, with a sharp knife and sandpaper, carve it to the proper cross-sectional shape, using the two wing sections on the opposite page as a guide. Clamp one end of the wing to your workbench, score the top surface along the longitudinal centerline, crack the wing at the scored line, and raise the free end so there is ⅞″ clearance between the tip and the bench. Support this end with a block of wood and cement the centerline crack. While this is drying, make the stabilizer in a similar fashion, using ⅛″ material. It is not necessary, of course, to crack this piece, as it has no dihedral. Glue it and the wing to the fuselage, holding them in place with pins until the glue dries. Fill the crevices around the wing root and the stabilizer with wood putty, building it up to form fairing fillets.

Make the fuselage-mounted machine guns and the wing-mounted cannons from thin doweling or match sticks. Go over the entire model with fine sandpaper; then apply several coats of wood filler to the surface, sanding lightly between coats. Finish with a dull camouflage paint. This should be greenish brown in color—somewhat darker than the olive drab used a few years ago. Paint the canopy white and outline it with thin black lines.

Use a disk of celluloid to simulate a whirling propeller. Cement it and the propeller spinner to the nose. The insignia are red circles.—BILL SPRAGUE.



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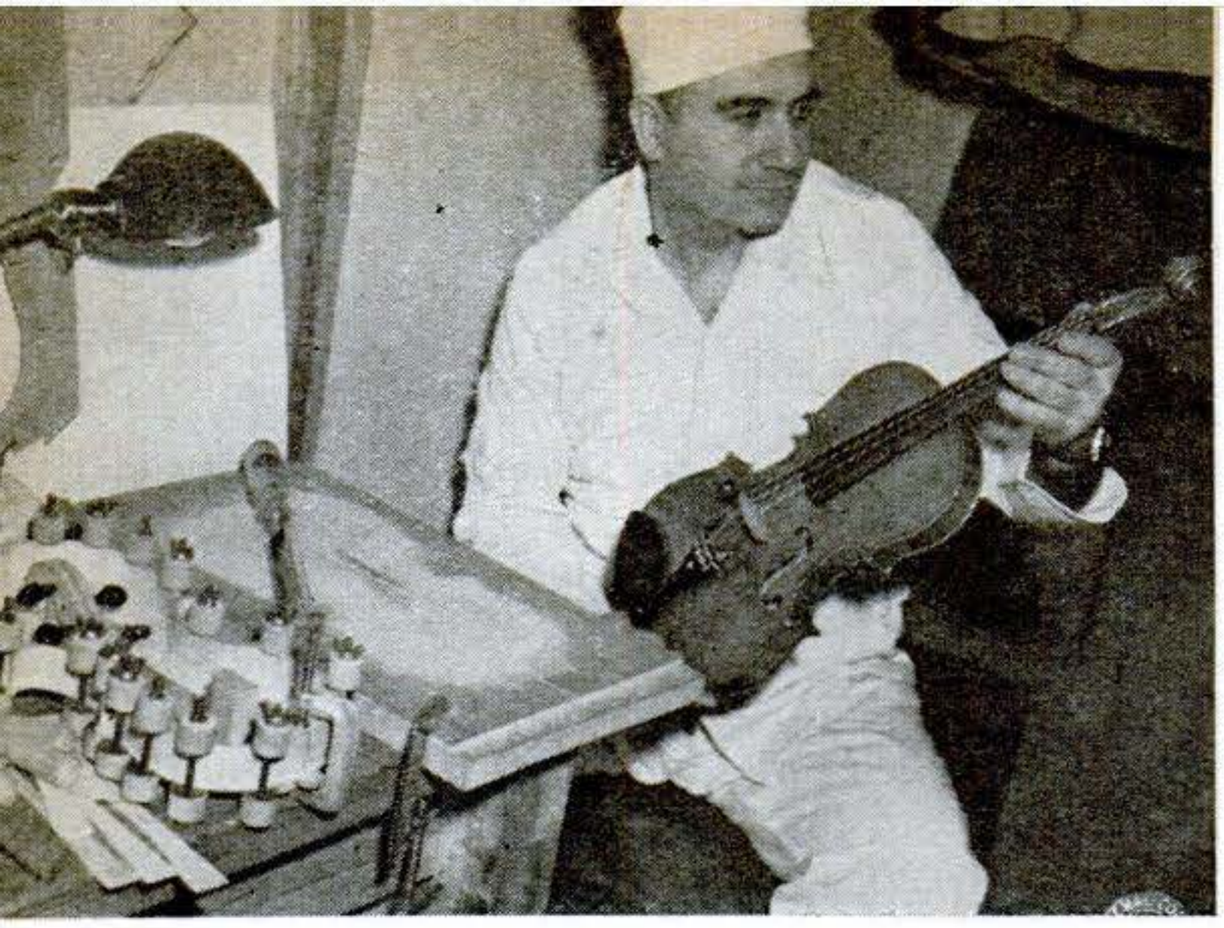
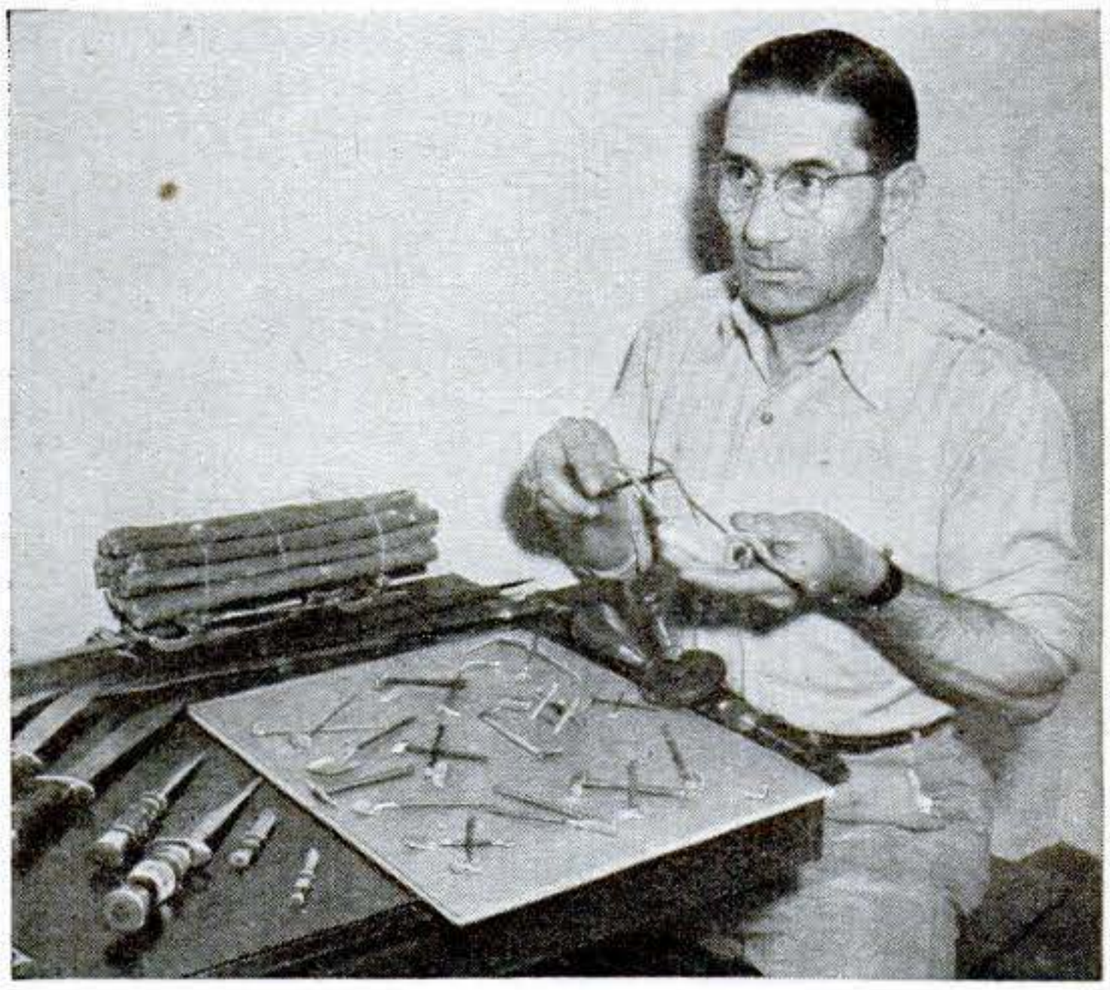


MUSIC AND COOKING are the hobby and vocation of T/4 Jacobus Theddorou, former New York restaurant proprietor and now a cook at Camp Reynolds, Greenville, Penn. Theddorou spends his leisure time fashioning violins at a barracks bench, putting more than 250 hours on each violin and finishing it with 15 coats of varnish. He makes his own tools and clamps.

MINIATURE FARM TOOLS and logging equipment are formed to scale from scrap steel by Alfred La Vasseur, master layout maker for the Douglas Aircraft Co., at Santa Monica, Calif. He has added commando knives for men in the services to his making of cant hooks, plows, picks, hoes, and scythes. The logging sled shown below with its load is one of his masterpieces.

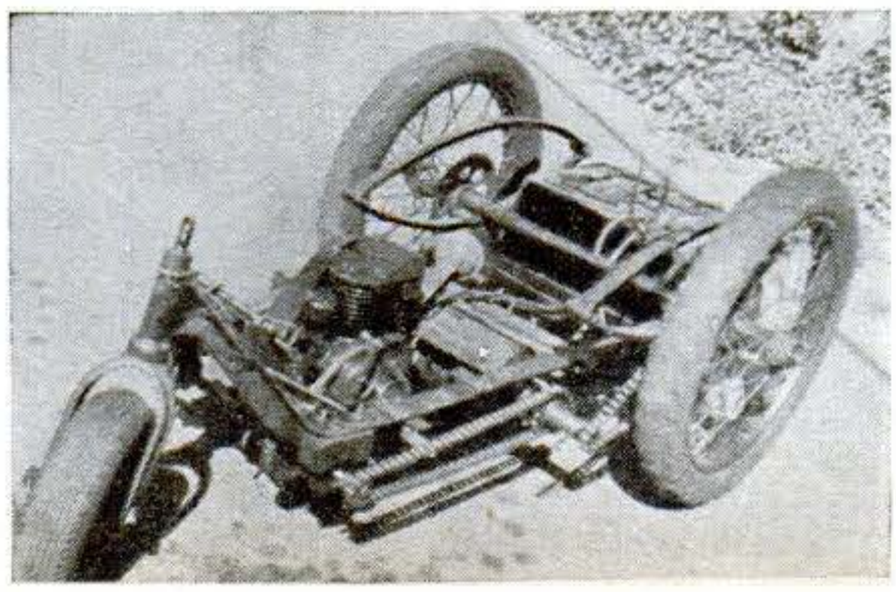


CRAFTSMEN AT WORK

BUILT FROM BLUEPRINTS of the original 25,000-lb. capacity power industrial truck, this 15″ by 20″ by 32″ scale model is operated by a motor and has all the controlling devices of the full-size machine. It was made in 1,300 hours by O. R. Heidenrich, Pittsburgh district manager of the Elwell-Parker Electric Company.

BOTH GAS AND ELECTRIC MOTORS propel a runabout constructed by R. H. Hamrick, of San Leandro, Calif. The body is a motorcycle sidecar set on a frame of angle iron. Motorcycle wheels are used on the axle at the rear, while a 3½″ by 12″ wheel is attached to the steering post.

For starting and short drives, an old Dodge 12-volt starter generator is fed by two ordinary 6-volt batteries. It operates for about 15 miles on one charge. A rheostat controls the speed, and a double-pole double-throw switch permits reversing. Power on the highway is furnished by a Briggs & Stratton ¾-hp. gasoline motor that is engaged by a dog clutch. This engine may be started by the use of the starter generator.



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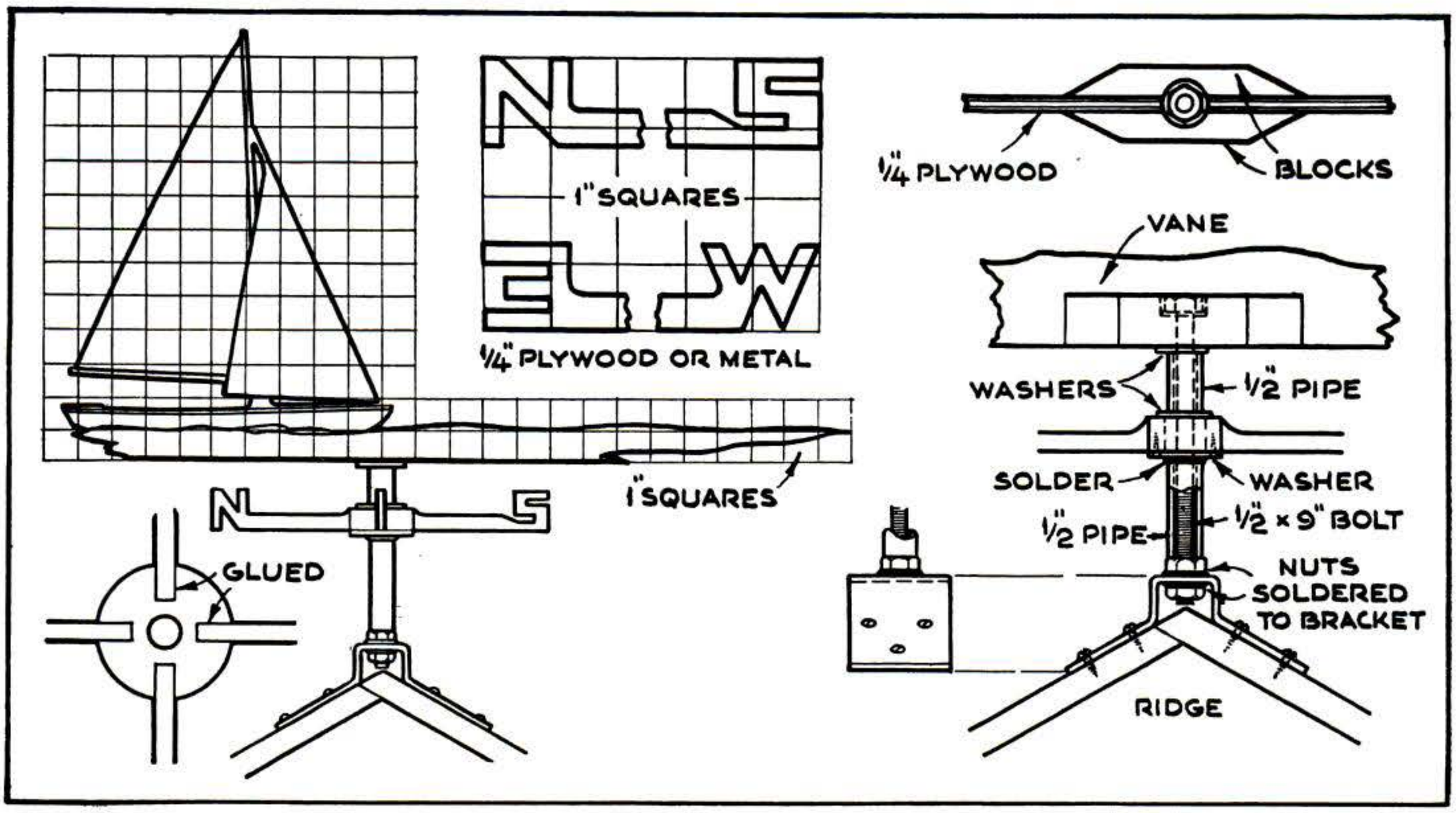


Nautical Weather Vane for Your Garage or Boat-House Ridgepole

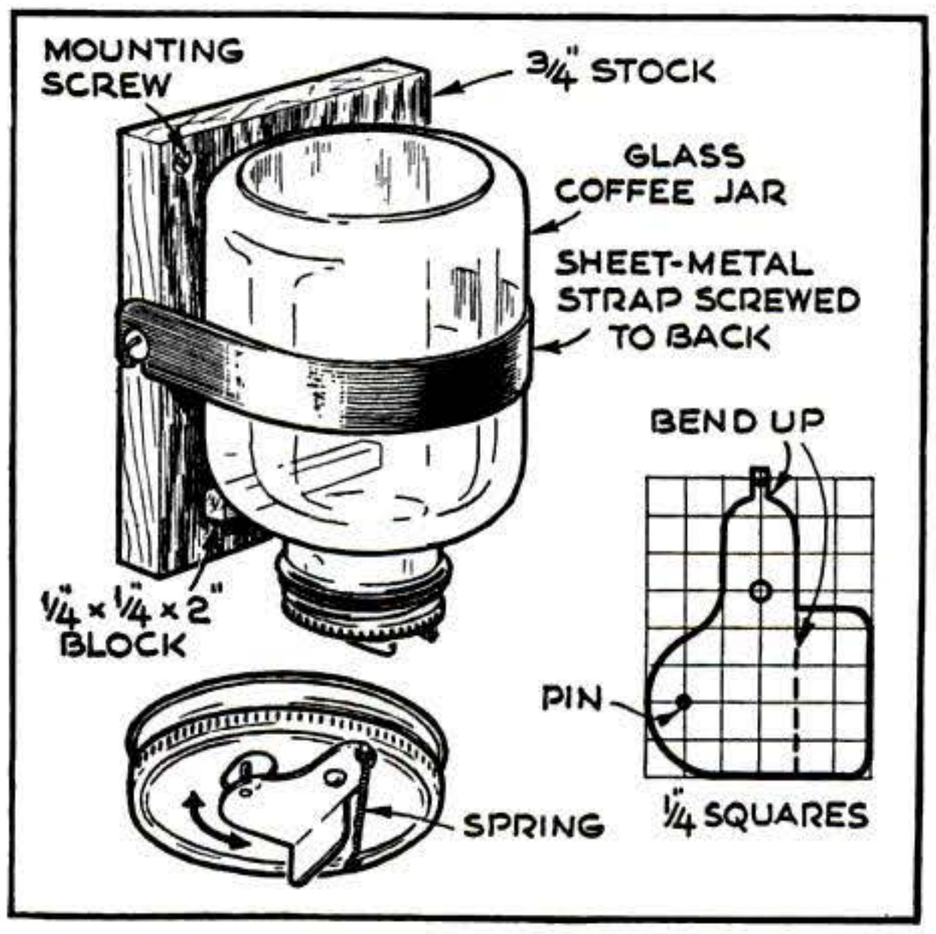
TO BUILD this weather vane, make patterns by laying out a grid of 1" squares on a piece of wrapping paper and, using the above drawing as a guide, sketching in the outlines of the vane and the compass-point indicators. Next, trace the patterns on your stock—either ¼" plywood or 16-gauge metal can be used—and cut the stock to shape. Screw or rivet two bearing blocks to the vane at the point where it rests on the post. Glue or rivet the compass-point indicators to a 9/16" i.d. collar of suitable material.

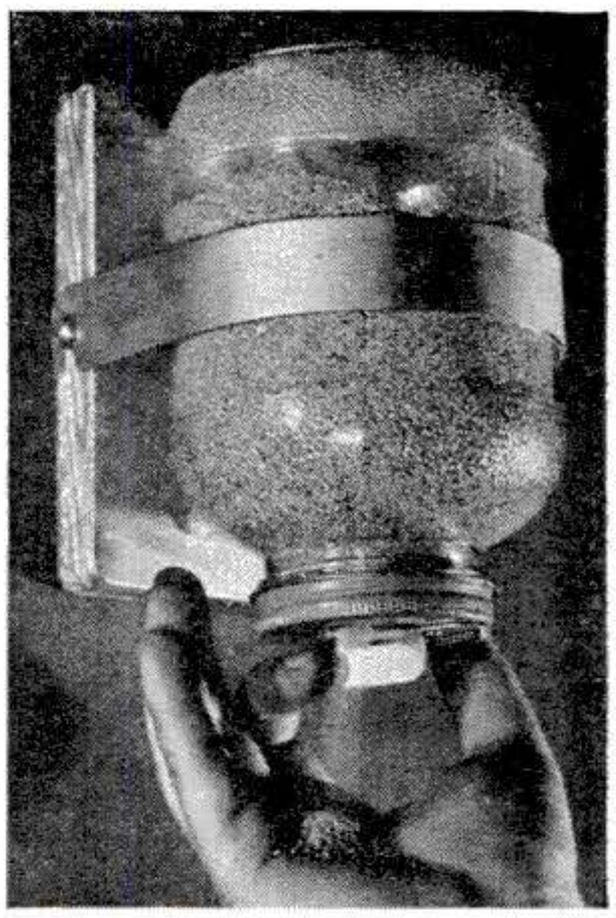
The post is built up of a ½" by 9" bolt, two nuts, three washers, and two lengths of ½" pipe. Assemble the parts, using solder where indicated, and mount the completed assembly on a bracket, which is made from flat bar and screwed to your garage or boat-house ridgepole. If wood or a ferrous metal is used in the construction, finish with two or three coats of waterproof paint of good quality.—WILLIAM F. CROSBY.

Simple Powdered-Soap Dispenser Utilizes Old Glass Coffee Jar

THIS soap dispenser is made from a glass coffee jar with a metal cover. Mount the jar on a ¾" backing piece and hold it in place with a 1/32" by 1" sheet-metal strap, which is screwed to the back, and a ¼" by ¼" by 2" block, which is also fastened to the back and prevents the jar from slipping down.

The dispensing device consists of a shutter which is detailed in the drawing; a 1/16" pin, which is riveted to the shutter and passes through a hole in the cover to act as an agitator; and a return spring. The hole should be completely covered when the shutter is closed and partially uncovered when the shutter is open. A small machine screw and nut, the latter soldered to the cover, hold the shutter.—A. O. BOHN.





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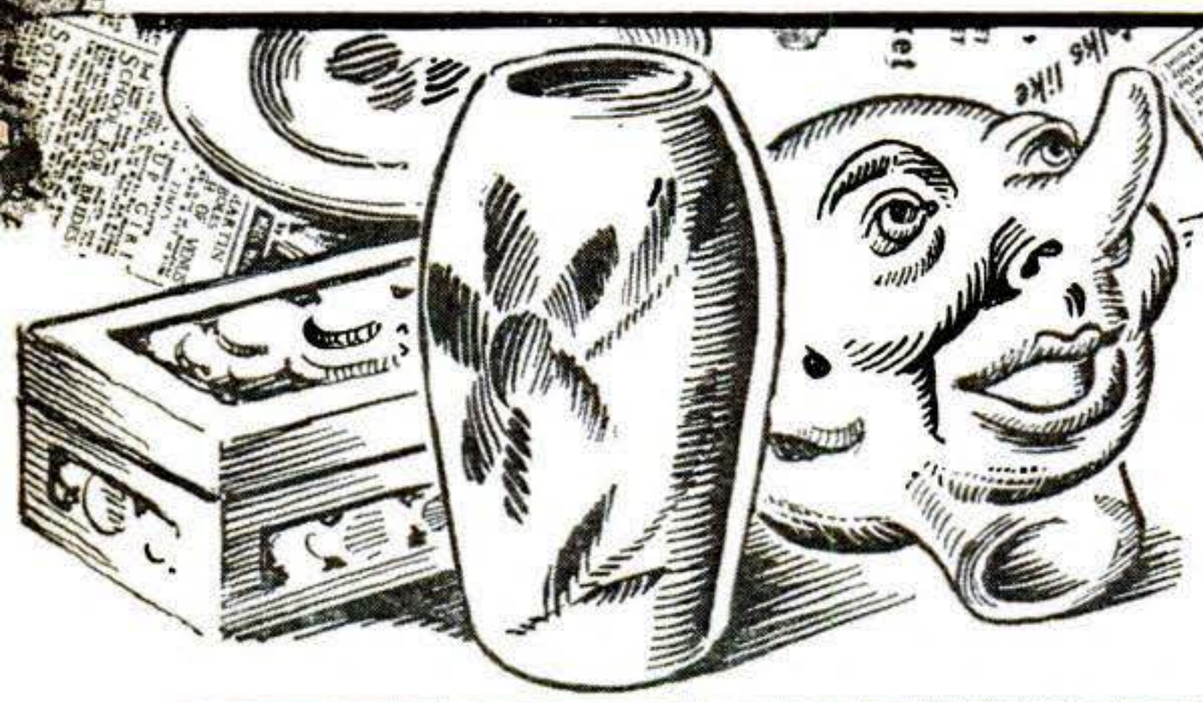
HOW TO USE PAPIER-MACHE

Old Paper and Paste Will Make an Excellent Craftwork Material You Can Adapt to Truly Distinctive Pieces of Your Own Design



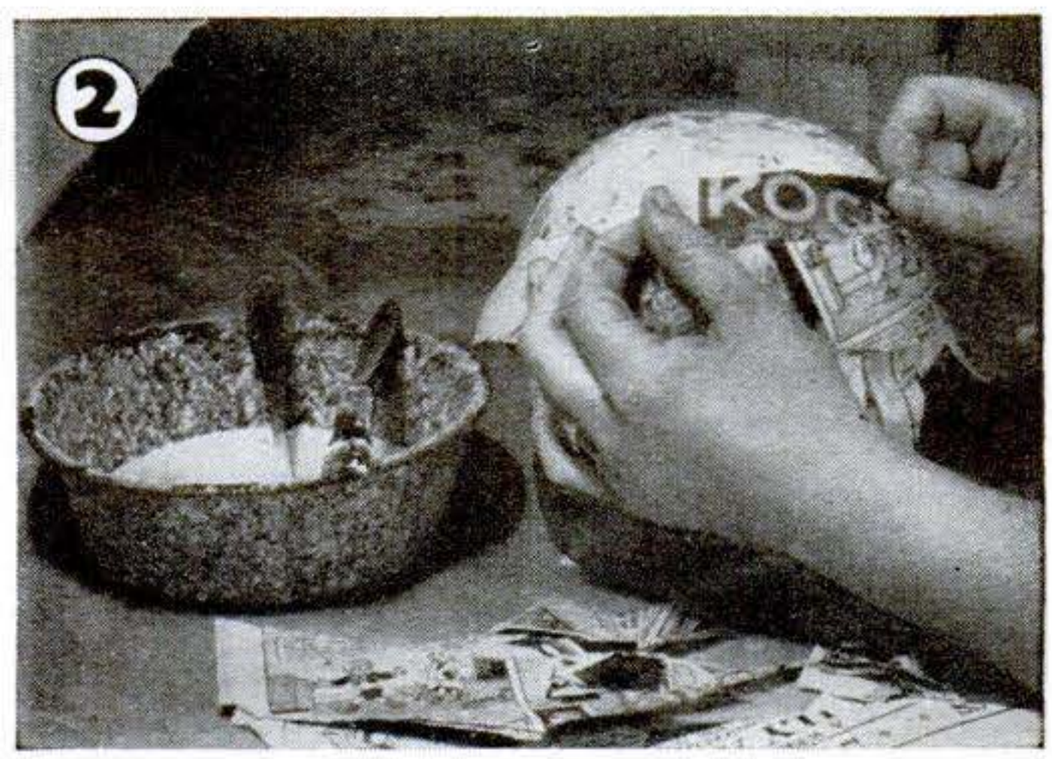
By ELMA WALTNER

PAPIER-MÂCHÈ, or paper pulp, has for ages been a favorite medium for craftwork. It is so simple to handle and so inexpensive to make that it is as practical for the novice to handle as modeling clay. Dolls, puppets, toys, figurines, bowls, and vases can be formed from it with little experience, and it is just a step further to the making of Halloween and Mardi Gras masks, store-window display figures, and enormous, grotesque animal figures.

As its name implies, papier-mâché is really paper chewed or torn and mashed into a pulp along with water and paste. For some types of modeling, however, such as bowls, trays, vases, and masks, many artists prefer to paste strips of paper together on a form rather than to use a mash or pulp. The principle remains the same, but the strips are somewhat easier to handle when the object is to be flat or hollow.

For either method, a commercial powdered wheat paste of the type used for hanging wallpaper will be found inexpensive and most satisfactory. If you wish to make your own paste, mix flour and cold water to the consistency of thin cream—a cupful of flour should be ample—and then add a little boiling water and stir over a low flame until the mixture thickens. A teaspoonful of alum will make the paste more adhesive, but isn't absolutely necessary, and a few drops of oil of cloves or cinnamon will preserve it if the mixture is to be kept for some time.

To make a bowl, use as a mold a smooth-surfaced vessel of the desired size and shape. Place this mold upside down over a jar or wood block; smear it with a light grease, such as petroleum jelly or a vegetable shortening; and then lay over it a layer of



torn or cut pieces of tissue paper, smoothing them on carefully to work out all wrinkles. The edges of the pieces should just touch; don't let them overlap too much, or there will be ridges on the inside surface of the finished bowl.

Now, using a small paintbrush, coat the entire surface of the tissue paper with paste, and then lay on, as in Fig. 1, wedge-shaped pieces and straight strips of newspaper that have been dampened in a container of water. Cover the surface with more paste, add a new layer of pieces of newspaper (Fig. 2), and alternate with paste and paper until the bowl has been built up to the desired thickness—about eight layers for a small bowl, or as many as 12 for a large one or for a plate or a tray. It is a good idea to use two different

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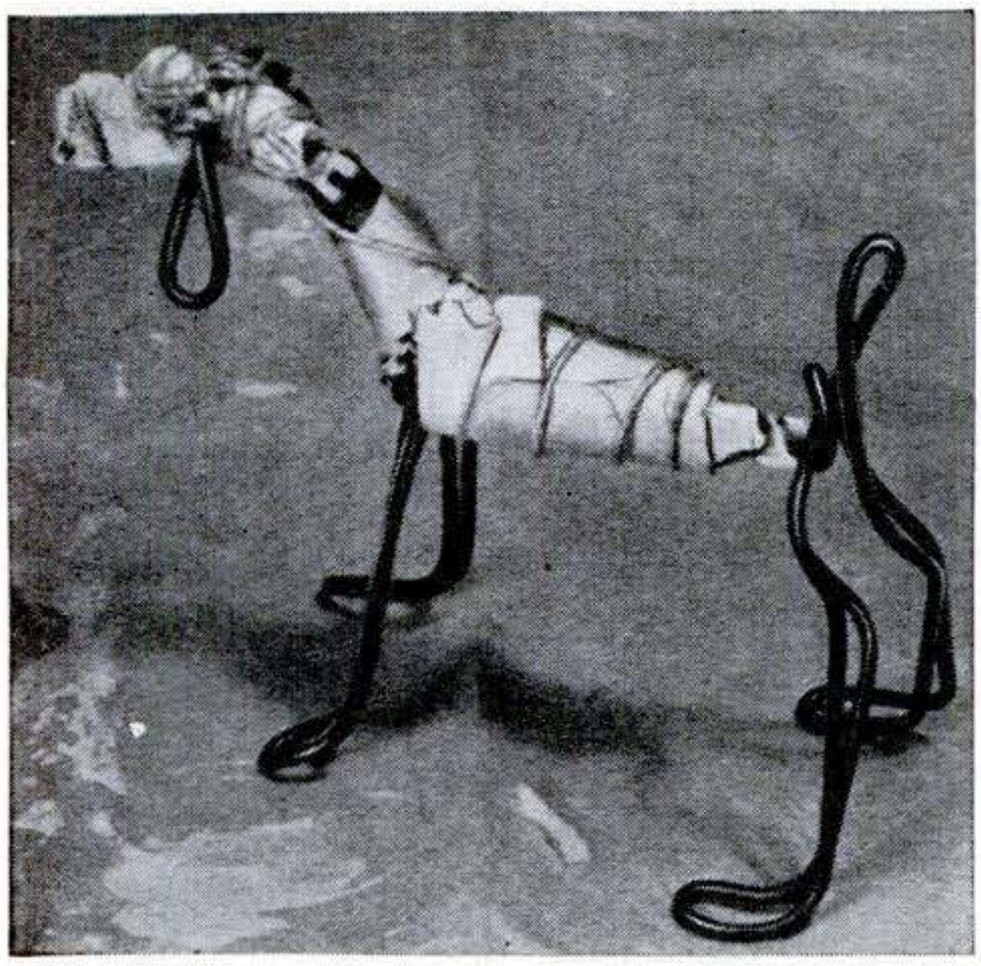


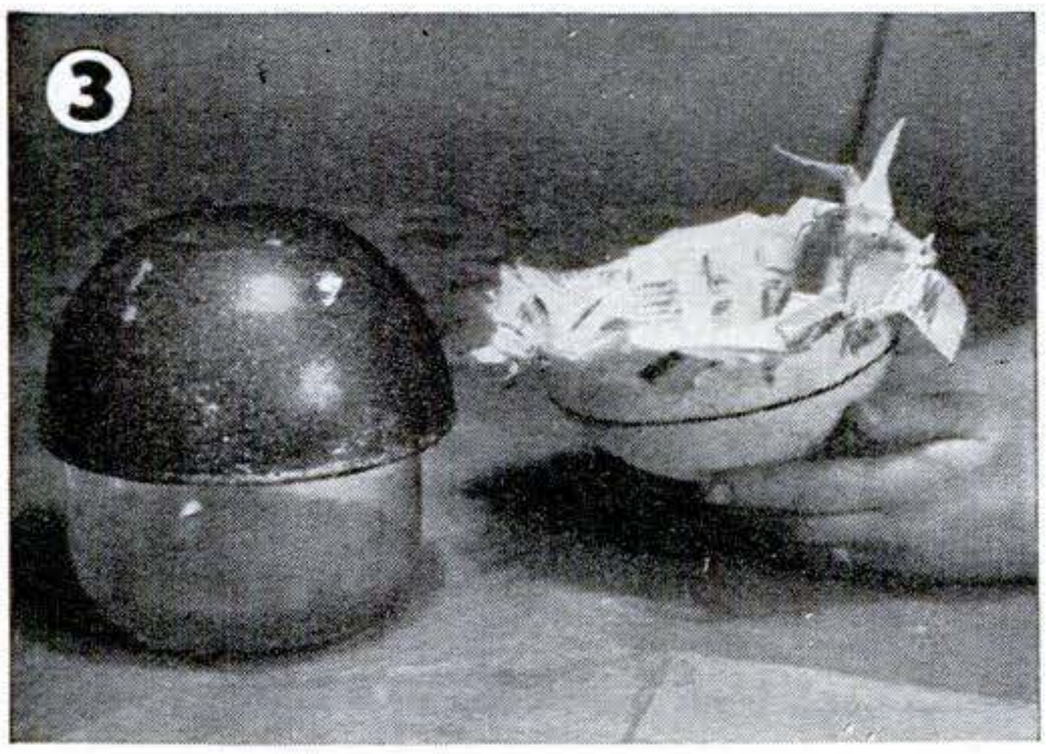
On this wire frame, an appealing little toy dog can be built up of papier-mâché. A muslin or paper wrapping saves time in building up thick parts such as the body

Bits of pulp mixed with paste are put on and pressed to the frame. Shape roughly as you add each new pulp daub

Finish the modeling with the fingers or a flat stick. After the piece has dried thoroughly, apply enamel or oil paint

types of paper, ordinary newspaper, for instance, and colored-comic sheets or brown wrapping paper. Then if the type of paper is changed for alternate layers, it will be easy to distinguish places you have missed and to fill in any chinks.

Take care to work out all wrinkles as each layer is applied, and do not let any of the edges overlap. Roughness can, of course, be smoothed with fine sandpaper, but it is easier to keep the layers smooth in the first place. Leave the piece on the mold to dry thoroughly. This may take several days. Mark around the edge a line for trimming, as shown in Fig. 3, and remove the piece



when it has dried. The tissue paper can be peeled easily from the inside.

Finish the piece with enamel or artists' oil colors, and you will have a bowl like that in Fig. 4, as attractive as it is useful. Oil colors take longer to dry than enamels, but lend themself more to hand decorating.

Vases may be made by the same process, using a glass jar for the inside. Since they will hold water, it is best not to grease and remove the glass. Other jars may be pulled off the form if the opening is at the large end. Or, where one cannot be pulled off readily, let the piece dry when only two or three layers have been applied; then slit one end of the piece, pull it off, join the cut places with pasted strips, and put on four or five more layers.

Pulp is used for the toy dog shown. Tear several sheets of newspaper into tiny pieces, pour on hot water, and let the mass soak overnight or longer. When you are ready to use it, masticate it further on a washboard or with the fingers, drain off all the water you can without squeezing, and mix in enough paste to form a dough. Now press out all the water possible so there will be little shrinkage when the finished piece dries. The pulp should be the consistency of modeling clay and should not stick to the hands. Build up the dog or desired figure on a wire or other frame, or model it from a ball as you would with clay. Finish with enamel or oil colors.

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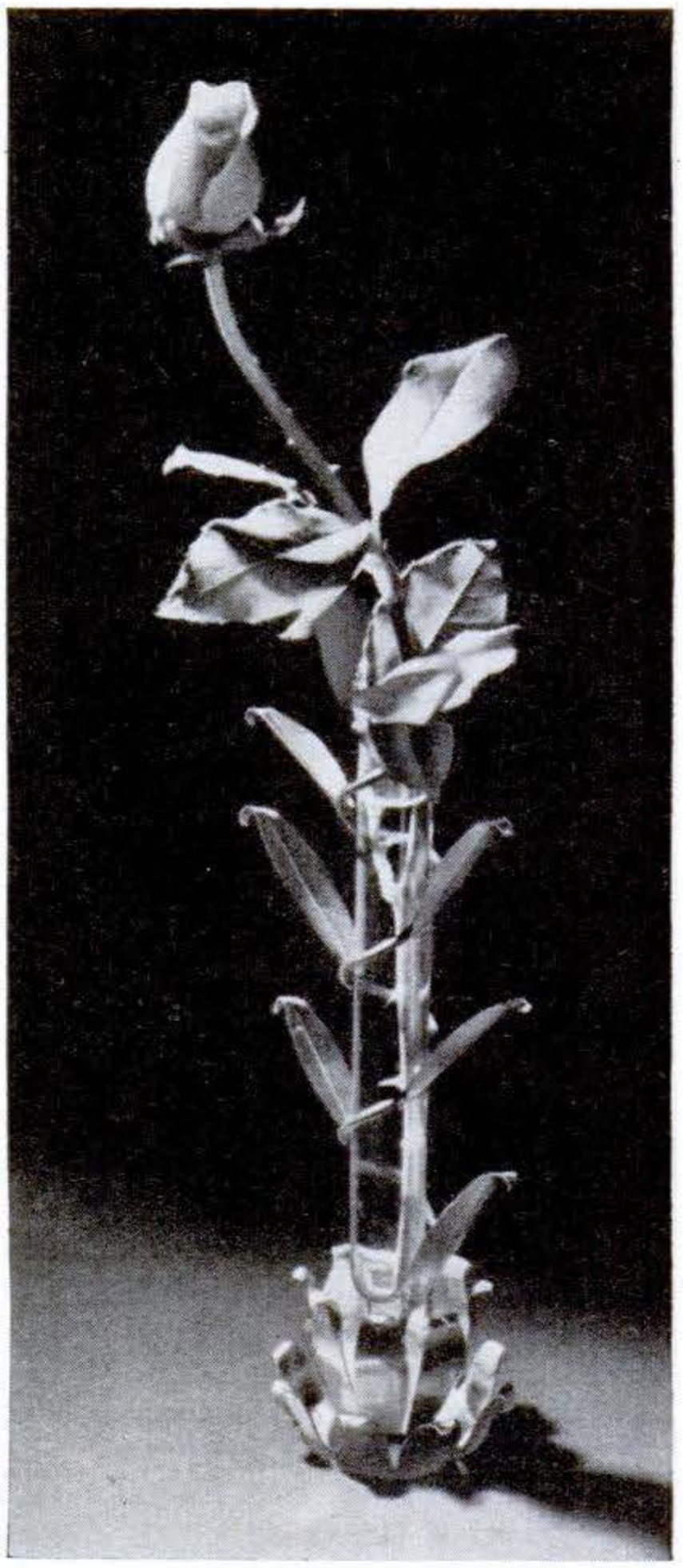
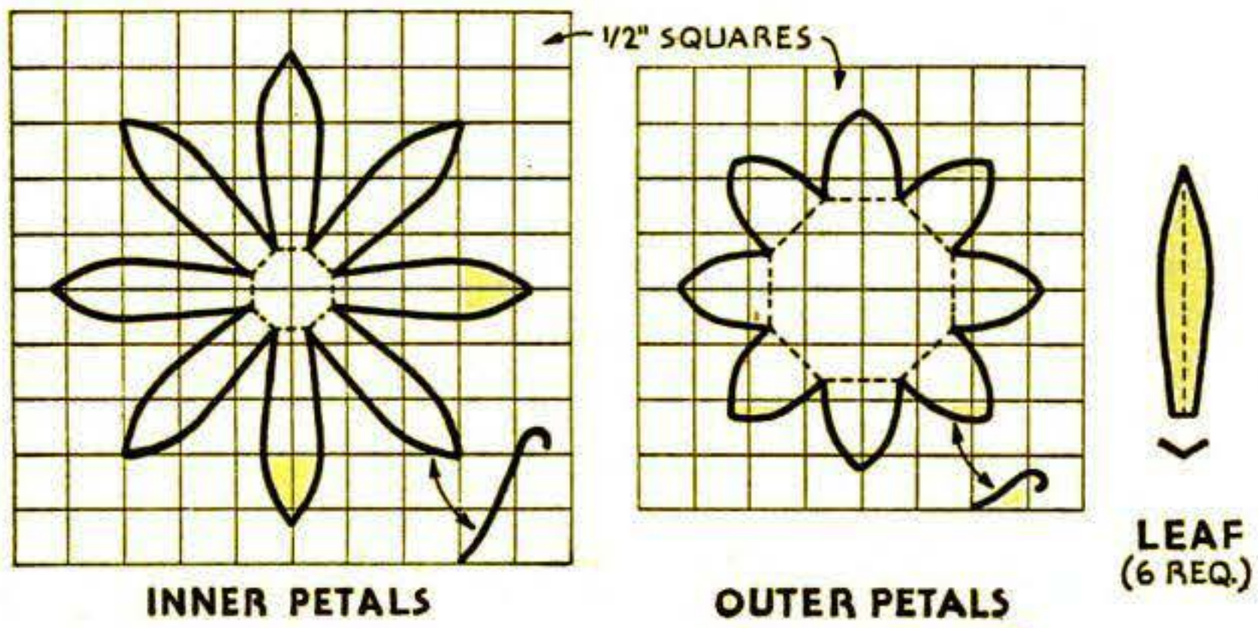
Bud Vase from Tin-Can Stock

THIS modern vase for holding a single bud can be made quickly from tin-can metal, clothes-hanger wire, and a standard test tube. Cut out patterns of stiff paper for the base and ornamental leaves, as shown in the drawing, trace the outlines on tin-can stock with a scriber, and cut out the pieces with tin shears. Bend the six leaves in a vise along their centers; then bend and curl the base petals and the ends of the leaves with round-nose pliers.

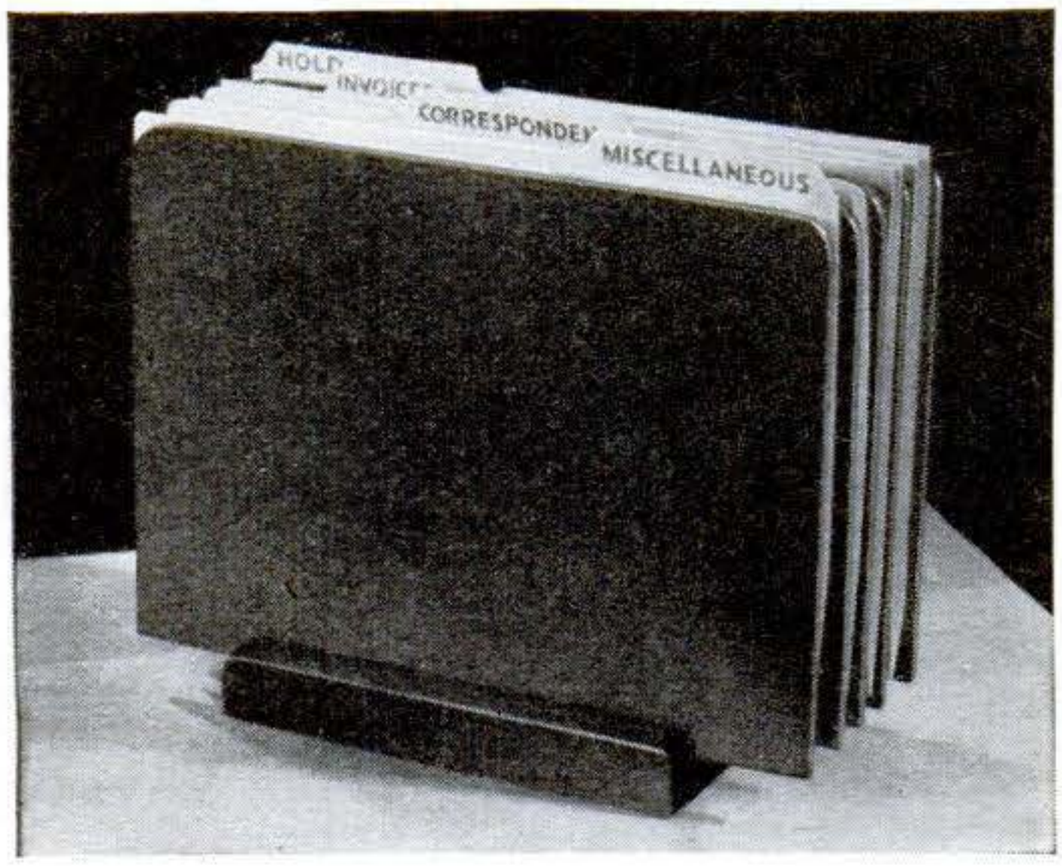
Clean the wire with fine steel wood or emery cloth. Bend ¼" of one end at right angles, hammer this flat, and shape the spiral around a dowel the diameter of the test tube. Solder the bent end of the spiral to the inner petals, solder on the outer petals, and then solder on the leaves. Polish with fine steel wool, apply clear lacquer to keep the metal bright, and insert the tube.—CARL W. BERTSCH.



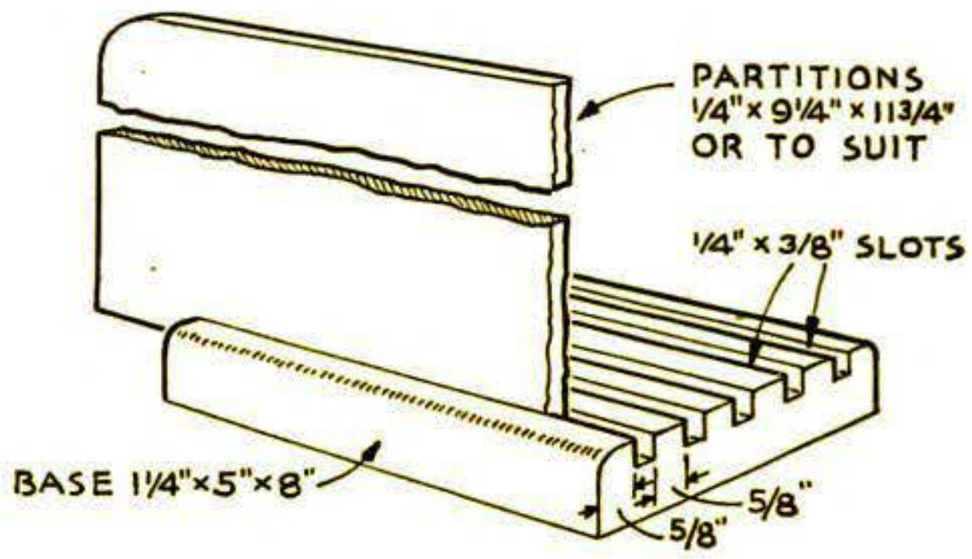


Partitioned Desk File Keeps Important Papers Separated

SIMPLICITY and convenience mark the handsome letter file shown below. It can be made of hardwood and finished to match the desk on which it will be used, or the base may be of any scrap stock and the partitions of plywood or composition board for a lacquered or enameled finish.



Grooves in the base for holding the partitions can be cut quickly on the circular saw or with a hand dado plane, or the base may be built of a solid piece with strips glued on ¼" apart to form the grooves. Round opposite sides of the base—the slotted ends as in the photo, or the front and back as in the drawing if this is found easier with a rasp. Finish to suit the materials selected.



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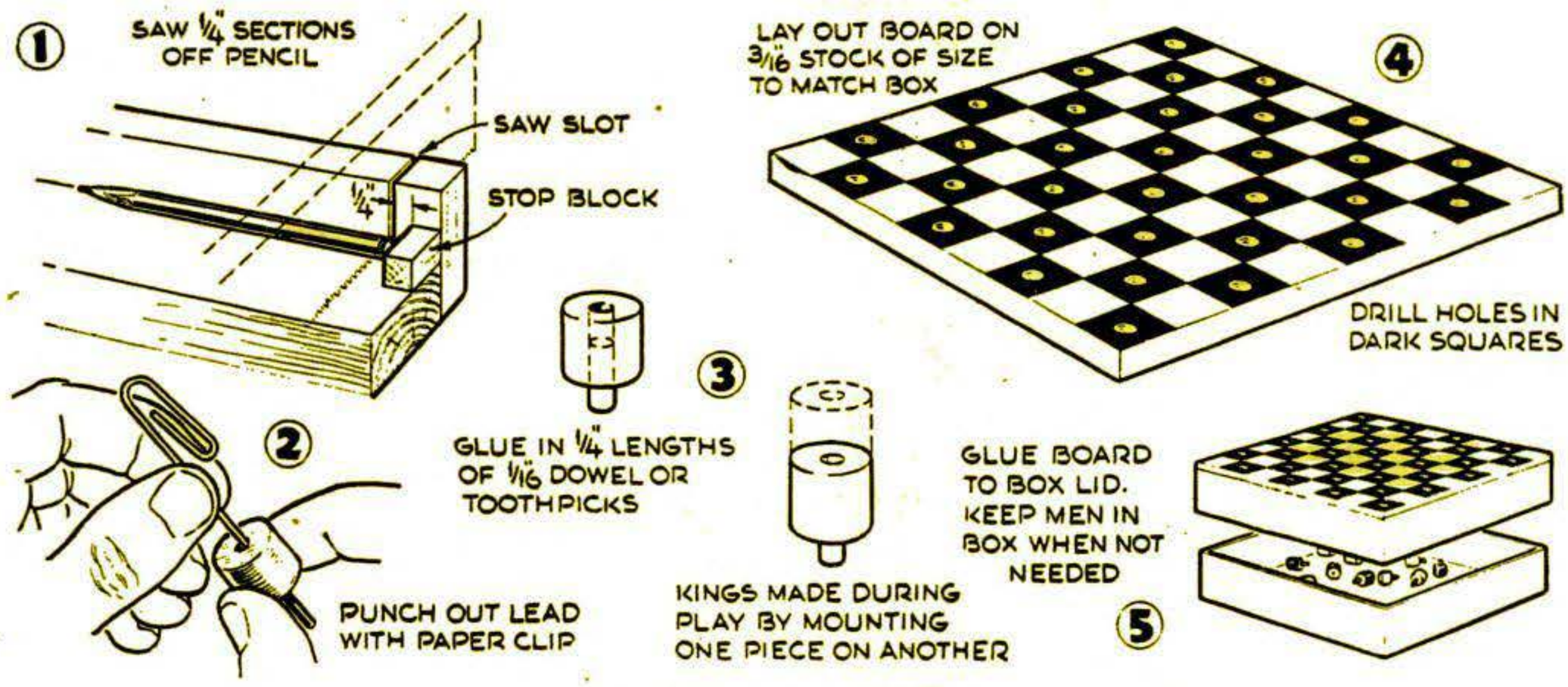
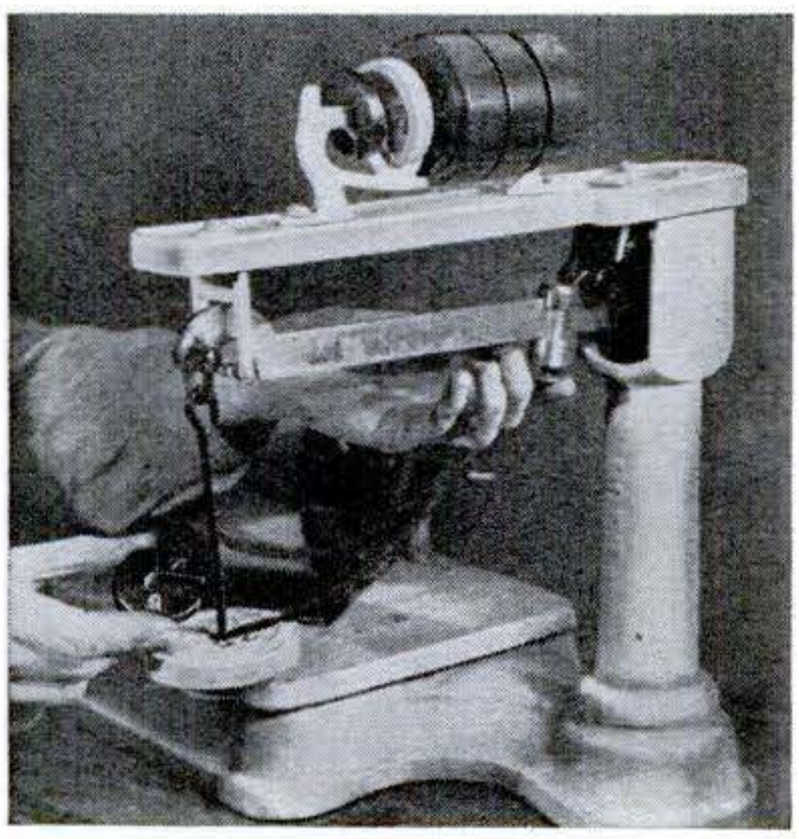
Checkers Cut from Colored Pencils Are Used in Portable Board



CHECKERS that can't be upset, and a combination board and box to hold the pieces, are practical features of this game unit. The checkers are sawed in the simple jig shown from round or hexagonal pencils of two colors. After the lead cores have been removed with a paper clip, small dowels or tooth picks are inserted and glued. A small, sturdy box serves as a base for the board, which is cut from 3/16" stock and glued to the box top. A colored pencil may be used to tint half of the squares in the checkerboard pattern, leaving the uncolored wood to mark the other squares. Holes are then drilled in the center of each of the dark squares.—F. MITCHELL.

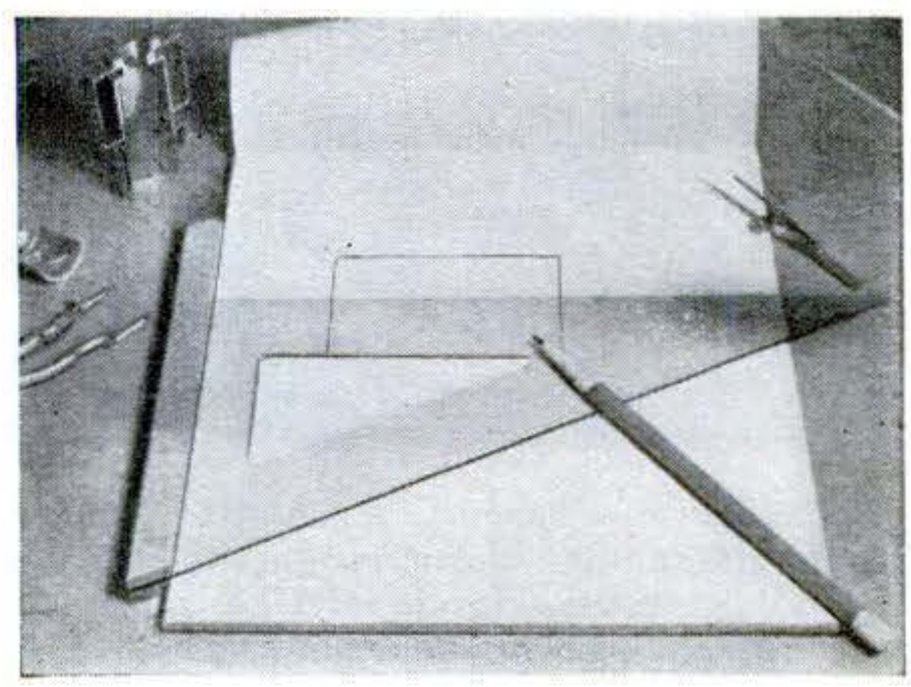


Colored Scale Weights Speed Up Work and Reduce Possibility of Error

EVEN a drab, work-a-day instrument like a platform scale may be brightened up and operated more efficiently by painting each weight in different colors. Bright hues make the weights easy to find when they are misplaced, while painting simplifies the process of selecting them from the scale-weight rack by combining touch and color identification. In this way, errors made in selecting weights are largely eliminated. Apply bright shades of different colors of enamel or lacquer to the weights. House paint may also be used, but avoid water color or casein paints as they may rub off in constant use.—W. E. B.

Plastic Triangle Forms T-Square for Full-Vision Drafting

DRAFTING on small pads or drawing boards is often awkward when a full-sized T-square is used, and particularly so since the square obscures much of the paper drawing surface. A drafting tool that eliminates this defect can be made from an ordinary 10", 60-deg. plastic triangle and two pieces of 1/8" by 1/2" by 7 1/2" strip steel, brass, plastic or hard wood. Clamp the strips flush to each face of the short side of the triangle. Three equally spaced holes are then drilled through the strips and counter sunk. After riveting the strips, the clamps are removed, and the rivets and sharp corners rounded off.—J. C. MAGEE.



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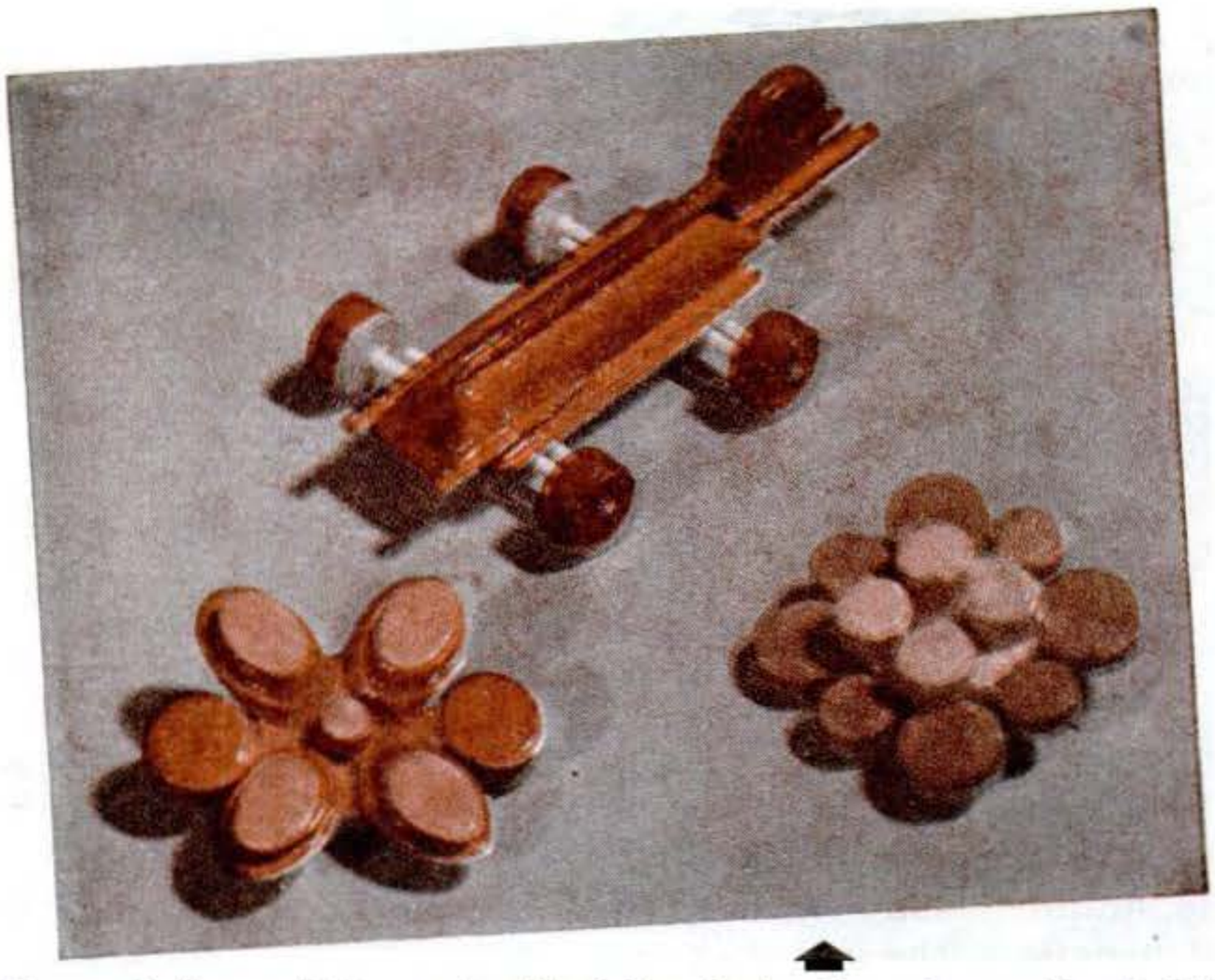
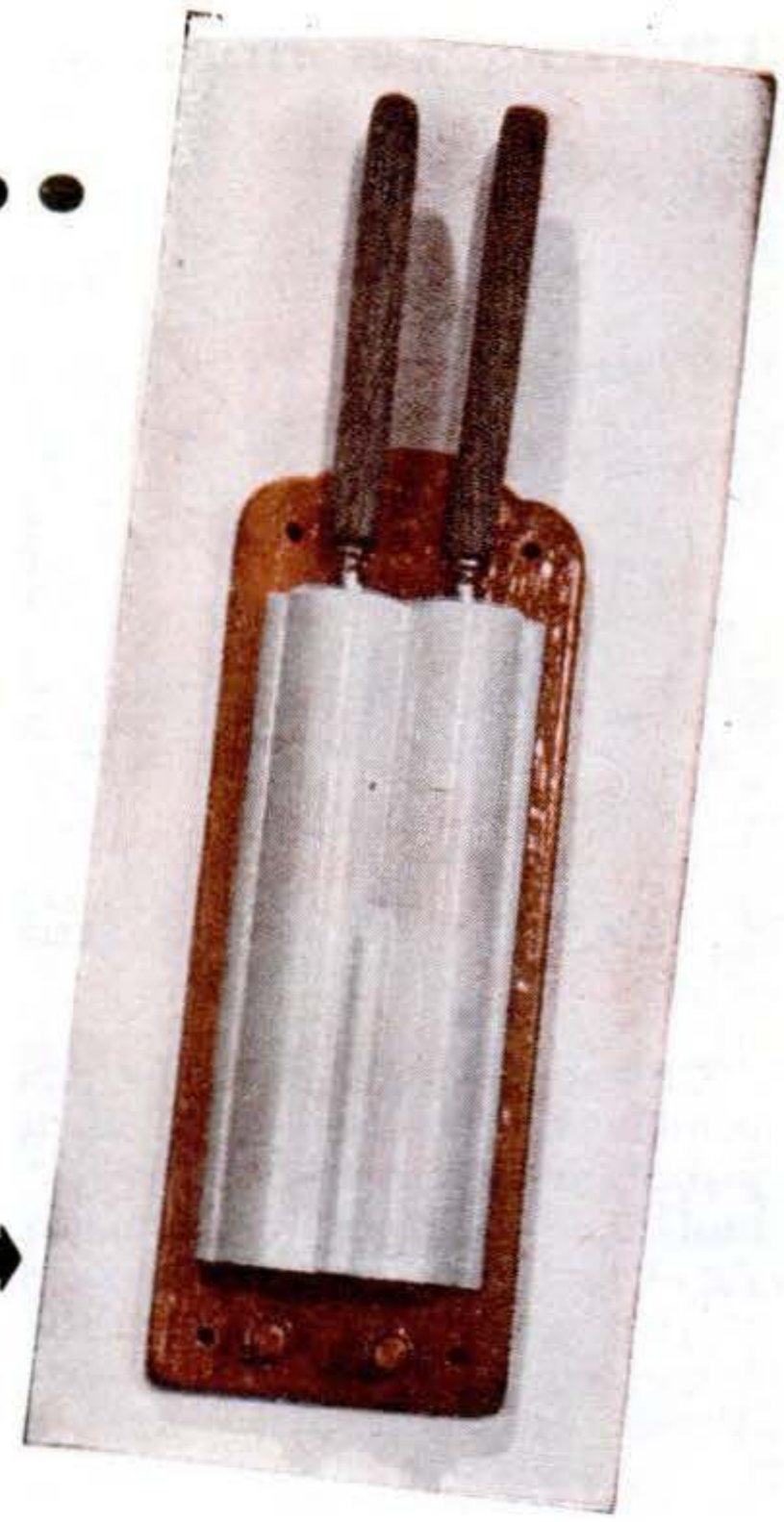
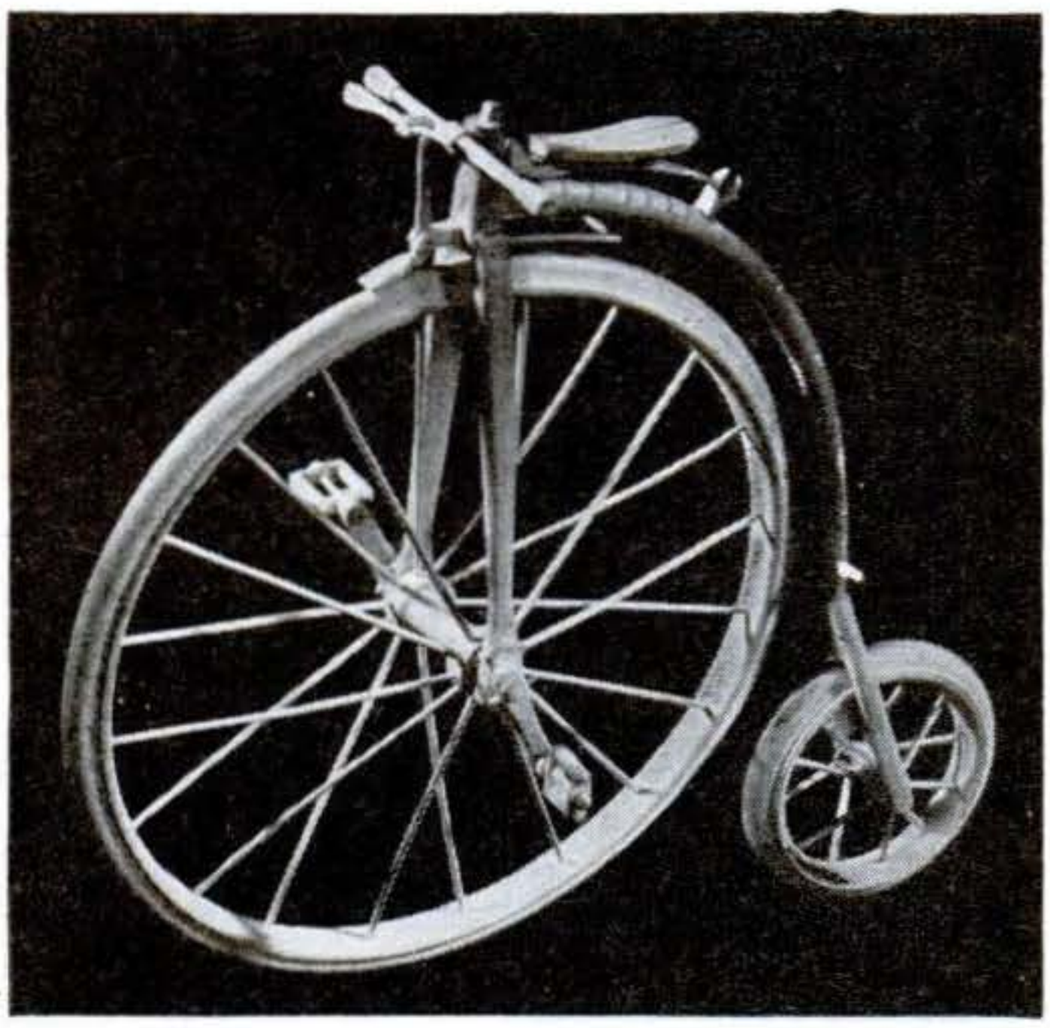
WINNERS IN OUR DOWEL CONTEST . . .



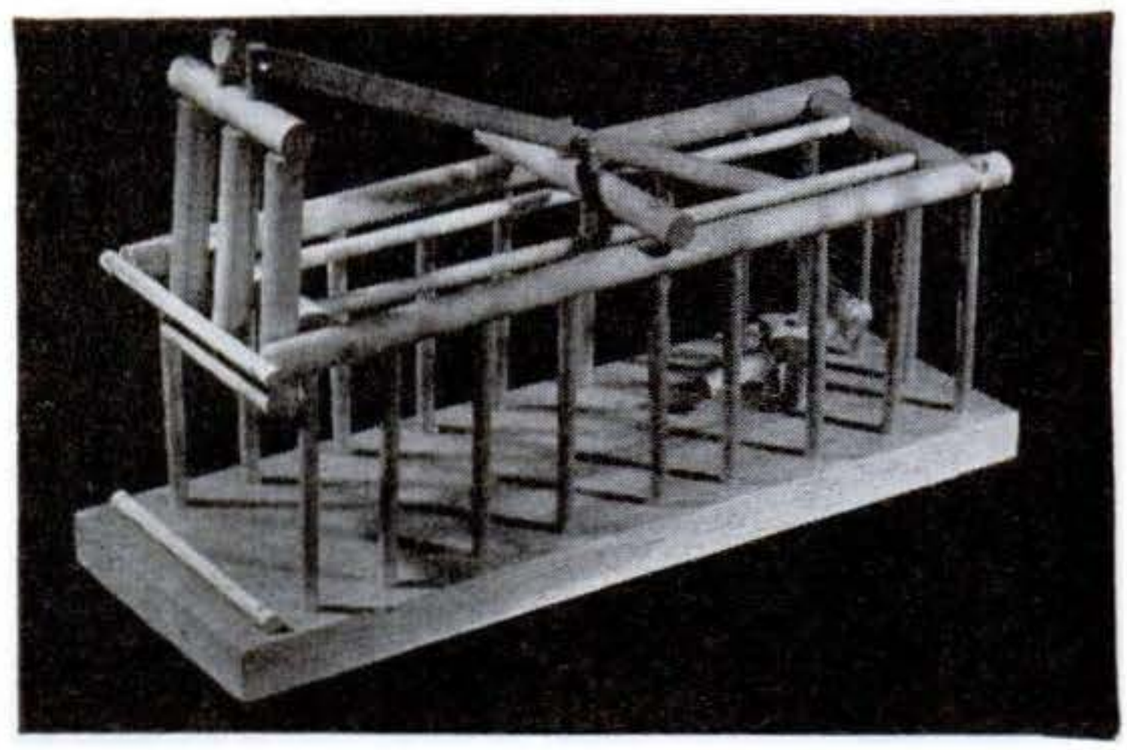


Four of the articles submitted by first-prize winner Frank W. Dresser—a futuristic rocket-car model, two lapel ornaments for the ladies, and, at the right, a wall-mounted knife holder

INGENUITY was the outstanding characteristic of the entries in P.S.M.'s recently completed dowel contest. So hard put were the judges in their efforts to pick the winners that they finally duplicated the $25.00 first prize by awarding a $25.00 special prize to the contestant who submitted the bicycle that is shown below.



Special-prize winner A. A. Avritt's entry was this nostalgic replica of an old-fashioned big-wheeler. Dowels were used for everything except the wheel rims, which were turned from a piece of flat stock



H. W. Gerdts won second prize with the rabbit-trap model shown above. In compliance with the rules, he used but one piece of flat stock, making the base from it. The gate actually falls when tripped

LIST OF PRIZE WINNERS

1st Prize: Frank Dresser, Philadelphia, Penna.
Special Prize: A. A. Avritt, Owensboro, Ky.
2nd Prize: H. W. Gerdts, Brooklyn, N. Y.
3rd Prize: Donald Schultz, St. Joseph, Mo.
4th Prize: George Coultrip, Berlin Heights, Ohio.
5th Prize: Joseph Ruel, Fifty Lakes, Minn.
6th Prize: J. B. Lighton, Los Angeles, Calif.
7th Prize: I. M. Fenn, Chicago, Ill.
8th Prize: Edward Stelmaszyk, Buffalo, N. Y.

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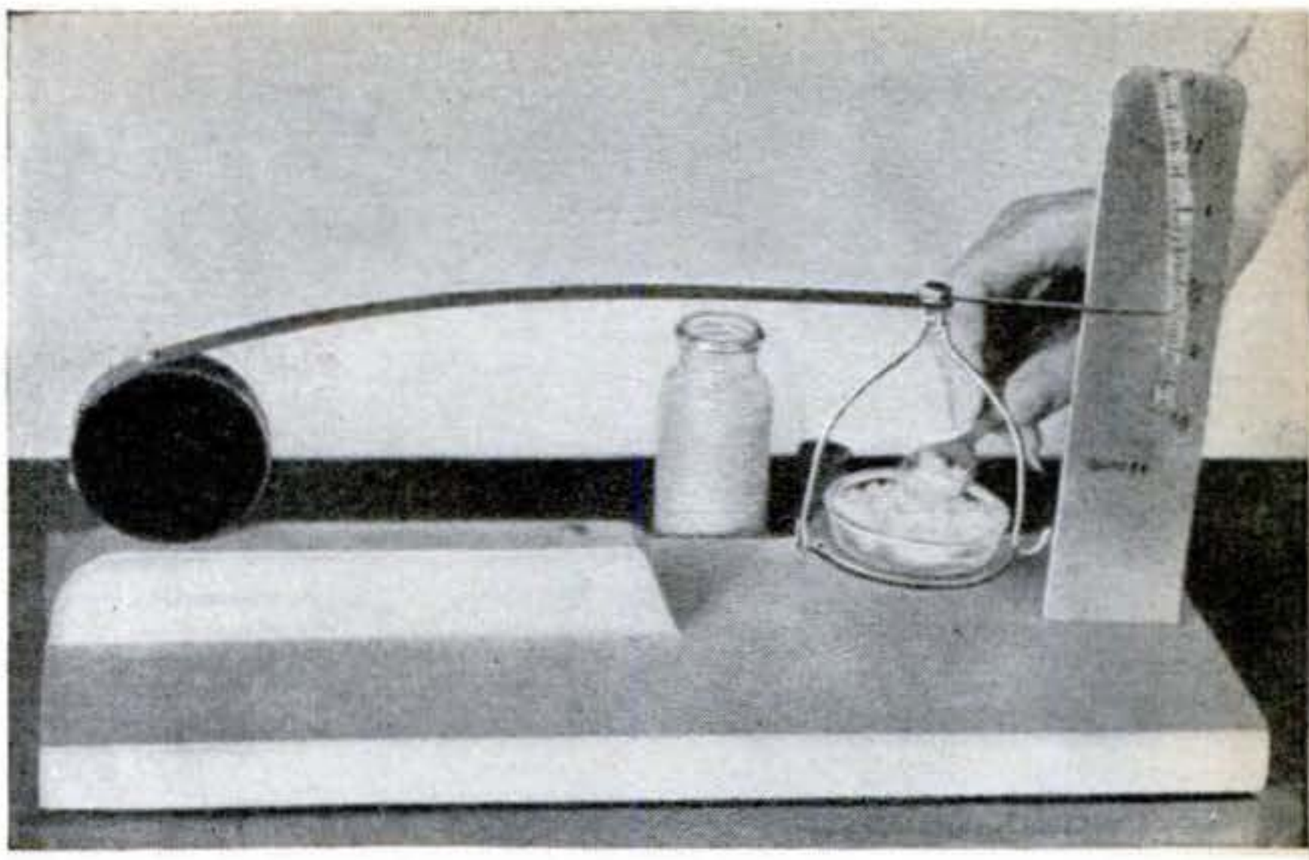
Sensitive Chemical Balance Made from Hacksaw Blade

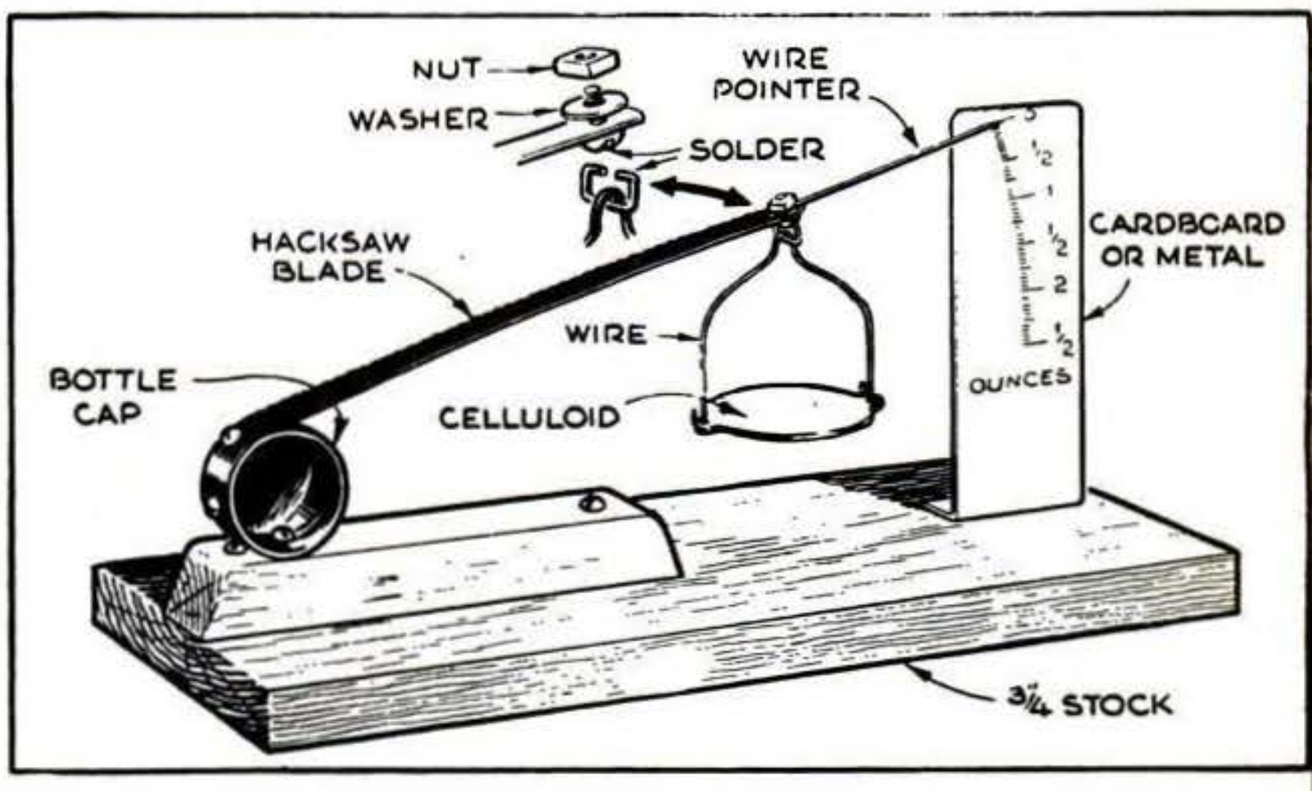
ACCURACY in your chemistry experiments, or in measuring photographic chemicals, will be increased by a sensitive balance. One that will measure to .05 oz. can be made from such simple materials as an old hacksaw blade, a screw cap from a canning jar, and a few lengths of wire.

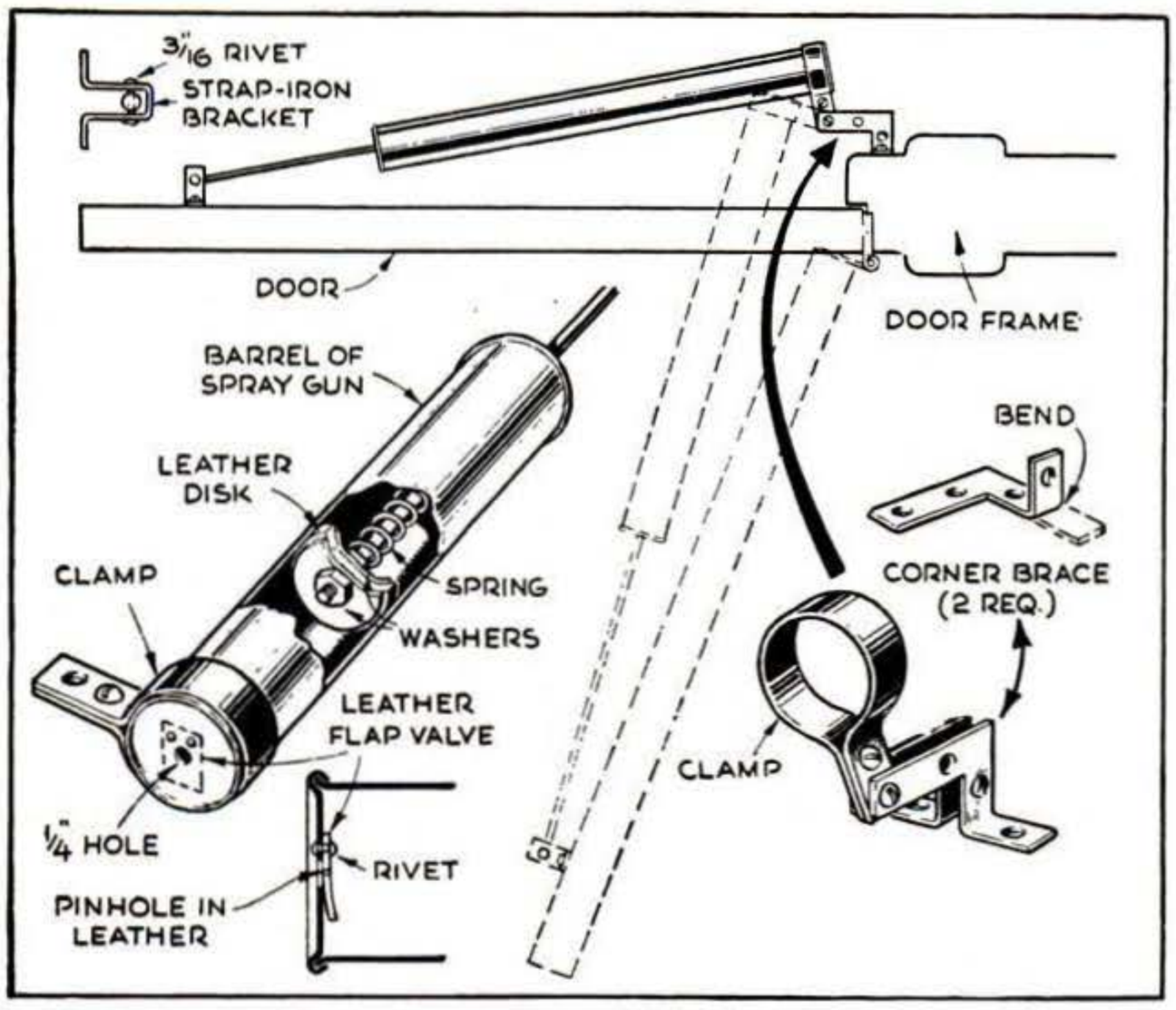
Grind the teeth off and anneal, if necessary, to drill a hole about 2" from one end; then drill two holes in the jar cap as shown so the blade can be bolted to it. Screw the cap to a wooden base through a third hole. Fasten the balance pan and a wire pointer at the other end of the blade, and set up a cardboard or metal scale on which the pointer will register. Calibrate with fairly new coins according to the following table:

Dime	38.5 grains
Penny	48 "
Nickel	77 "
Quarter	96.5 "
Half dollar	193 "

If you wish to calibrate a scale in fractions of an ounce, 437.5 grains equal 1 oz.—ROBERT F. BENENATI.







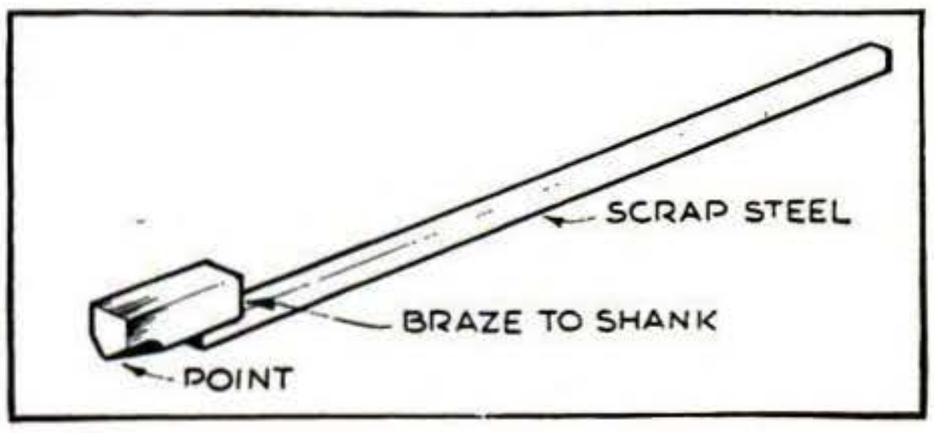
Spring Fitted to Piston Closes Door Silently

IF YOU are troubled by slamming doors, you can make an automatic closer from the barrel of a spray gun, a homemade piston, and an ordinary door spring, as shown in the drawing at left. For use on a screen or storm door, the bracket can be altered to fit between the outer and inner doors.

Make up the piston from a leather disk that will slide easily in the cylinder and from two washers slightly smaller in diameter. Attach them to the threaded end of the piston between two nuts. Solder the cylinder end back on after inserting the piston.—BERNARD MIGLIARO.

Glass Cutter of Tungsten Carbide

BRAZED to a short shank, a scrap from an old tungsten-carbide tool bit will make an excellent glass cutter. This tool alloy is exceptionally hard. Grind the point on a diamond or silicon carbide wheel to the shape shown and keep it sharp.—CARROLL MOON.



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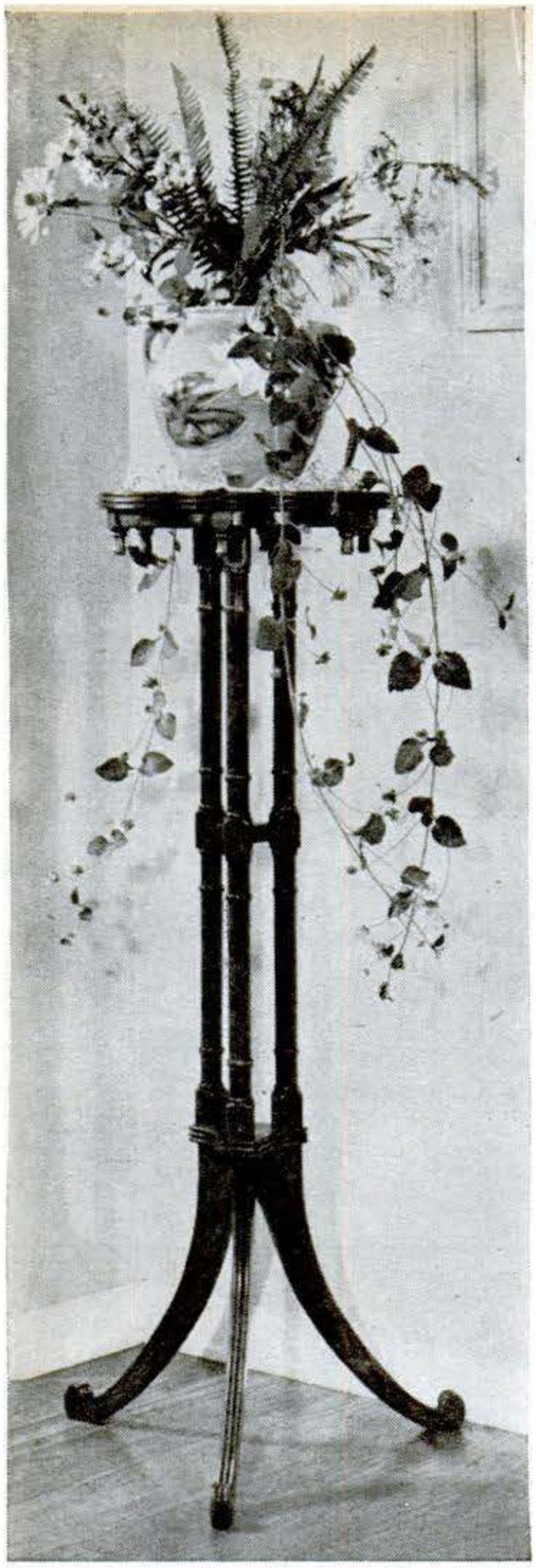


Eighteenth Century

AN HEIRLOOM YOU CAN

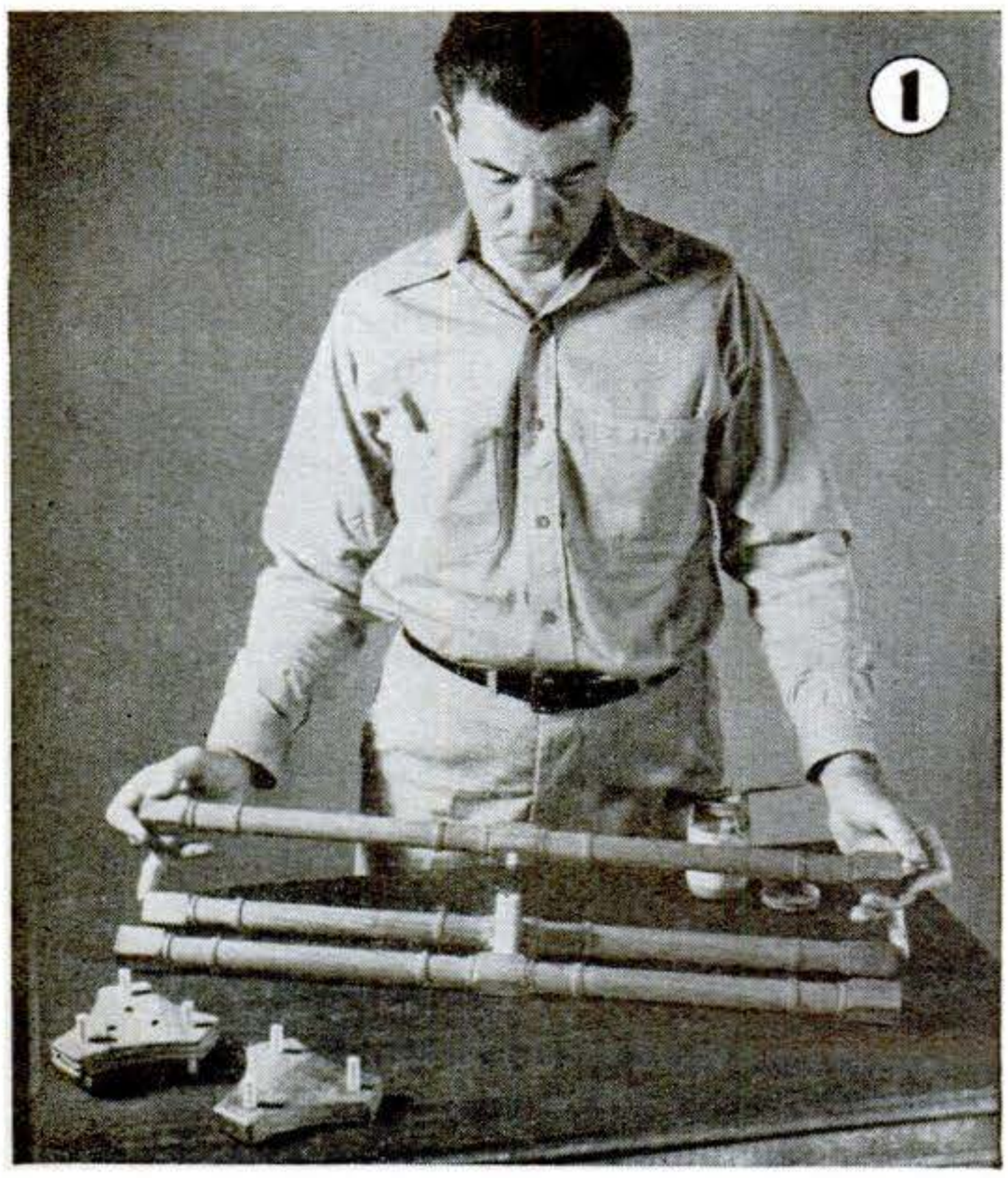
By Frank Hegemeyer

THIS three-footed stand is a charming piece that follows the trend of the master cabinetmakers of the eighteenth century. Besides making a handsome addition to the furniture of a living room, it will serve admirably for the display of a favorite statuette or potted flowers or greenery.

The three turned columns present no difficulty except that they must be accurately centered in the lathe because of the square sections at the ends and in the middle. All necessary dimensions are given in the drawing. If your lathe will not accommodate a 28" length, it is possible to make each column in two pieces and join them with dowels. In this case, have the lower section contain the center square portion.

Three pairs of dowel holes are bored in the lower plate, while only three holes are required in the upper one. First cut a paper template to the shape of the lower plate, and then spot the six holes on it as shown. Place this pattern on the bottom of the lower plate and transfer the location of the holes with the point of a nail or an awl. The three inner holes of the pairs are then bored part-way through to take the inside dowels from the legs, and the outside holes of the pairs are bored all the way through so that a single dowel through each will join both a leg and a column.

Impressions for the dowel holes in the legs and in the upper plate can then be made with dowel centers. Note that the upper plate is joined to the table top with

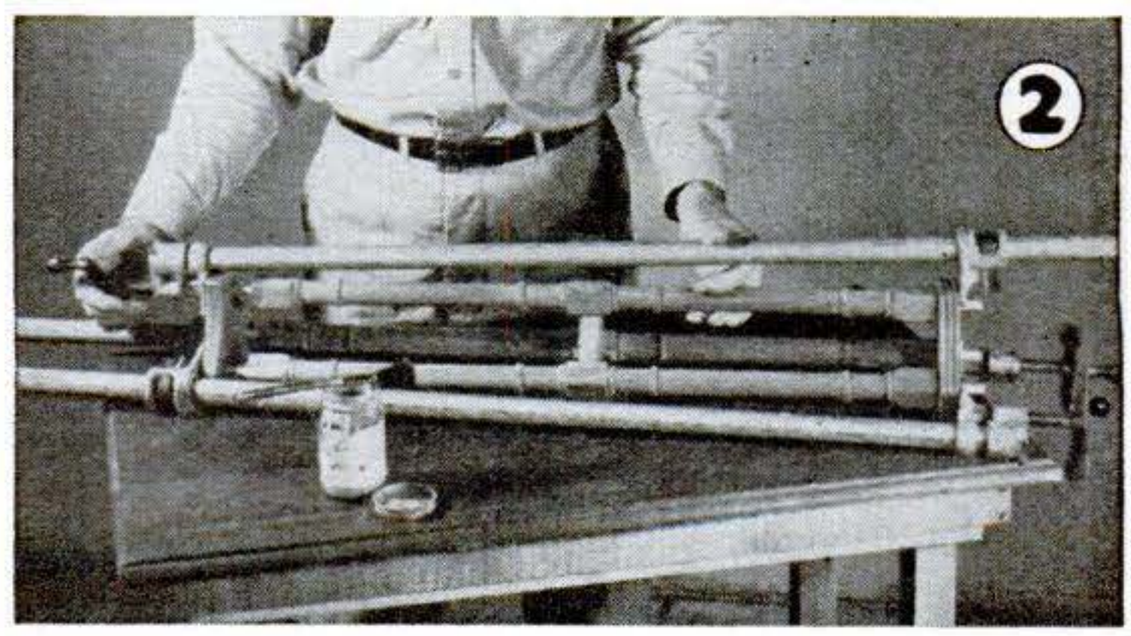


1 Join the columns to the center block first. The dowels in the plate in the left foreground go all the way through and join the legs and columns

2 Assemble the plates and columns with glued-in dowels and clamp the piece firmly. It is best to make up a trial assembly before applying glue

3 If the legs are fitted accurately they can be glued to the lower plate without use of clamps

4 Glue alone is sufficient to hold the segments under the top. Fit and glue each in its turn



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Pedestal Stand

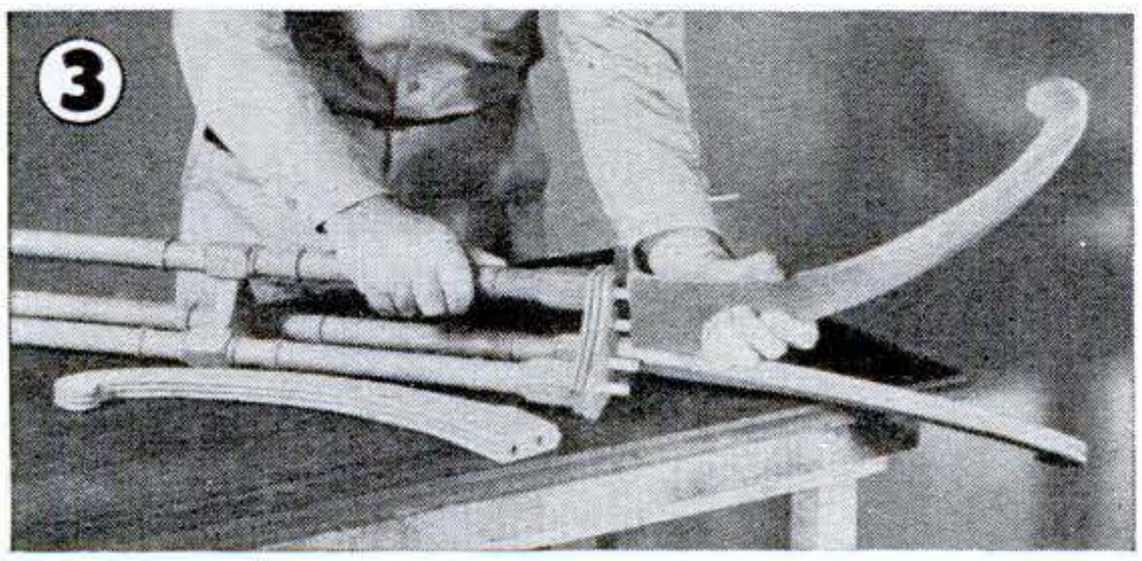
MAKE FOR THE YEARS TO COME . . .

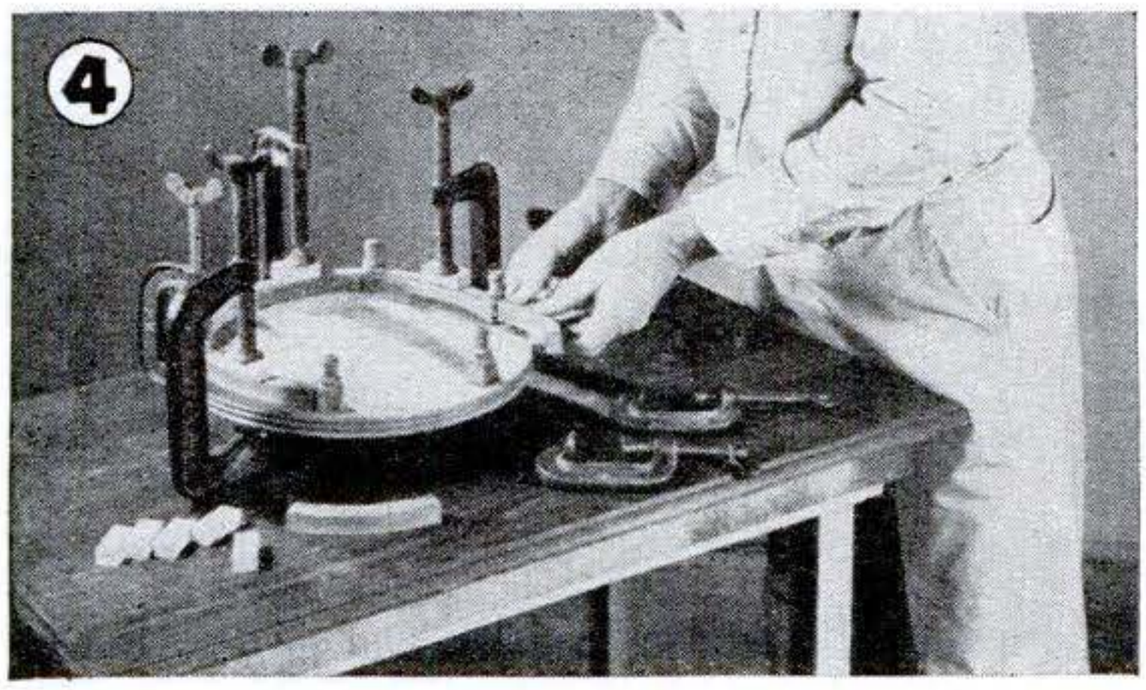
screws and that dowel holes are needed only for joining it to the columns. These holes may be just deep enough for firm joints. Bore the ends of the columns in the lathe.

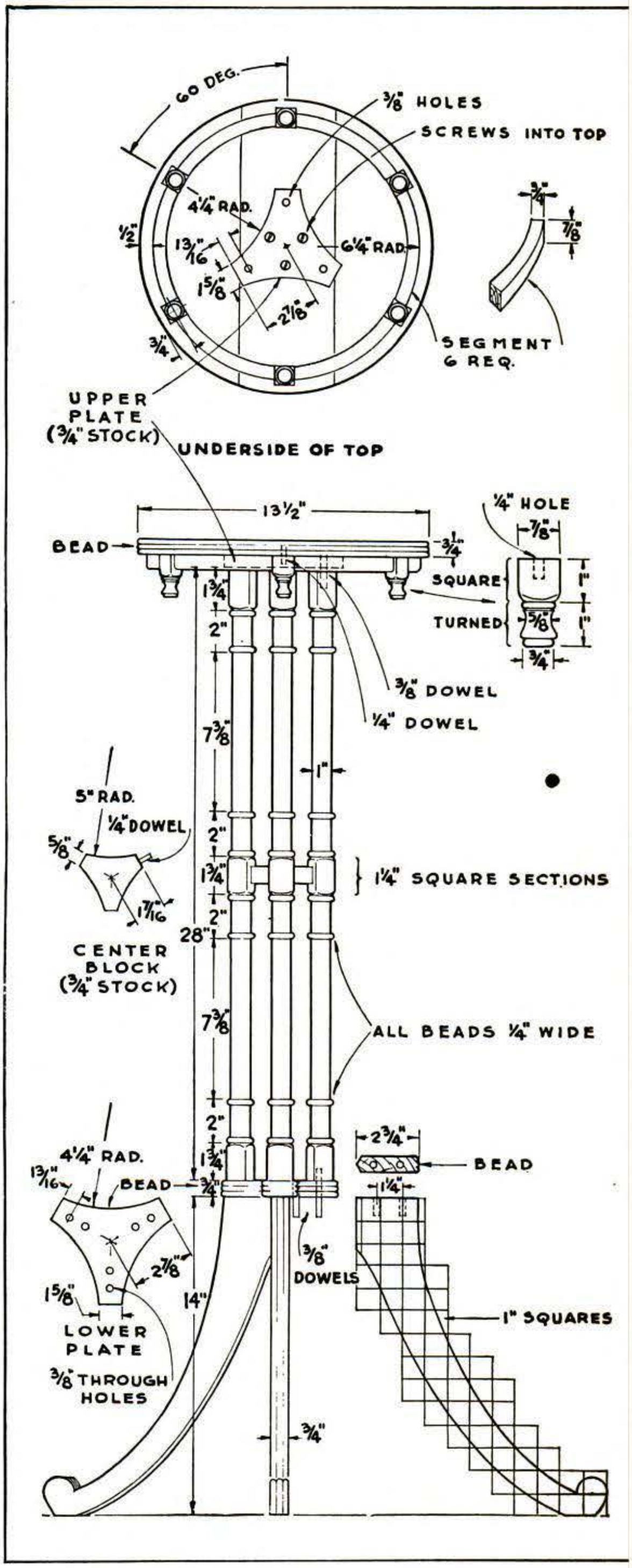
A template for the center block is easily made by sandwiching a sheet of paper between the columns and the lower plate, which are assembled temporarily for this purpose. Mark lines along the inside edge of the squares and add the curves.

In laying out the plates, center block, and table top, be sure to have the grain of the stock run in the same direction for all, that is, in line with a common leg. Bore the squared ends of the center block and the center squares of the columns for dowels, and assemble these pieces first, as shown in the photos, before adding the plates and legs. Shape the legs and table-top segments with the grain running lengthwise, bead the legs and lower plate, and build up the top from three pieces with heart and sap sides alternating to reduce warping. Ornamental turnings are fastened under the top with ¼" dowels.

Walnut and mahogany are particularly good woods for furniture of this sort. Rub in a filler, and sand lightly after 48 hours. Use lacquer or varnish, rubbing the top to a high gloss and the rest to a semigloss.







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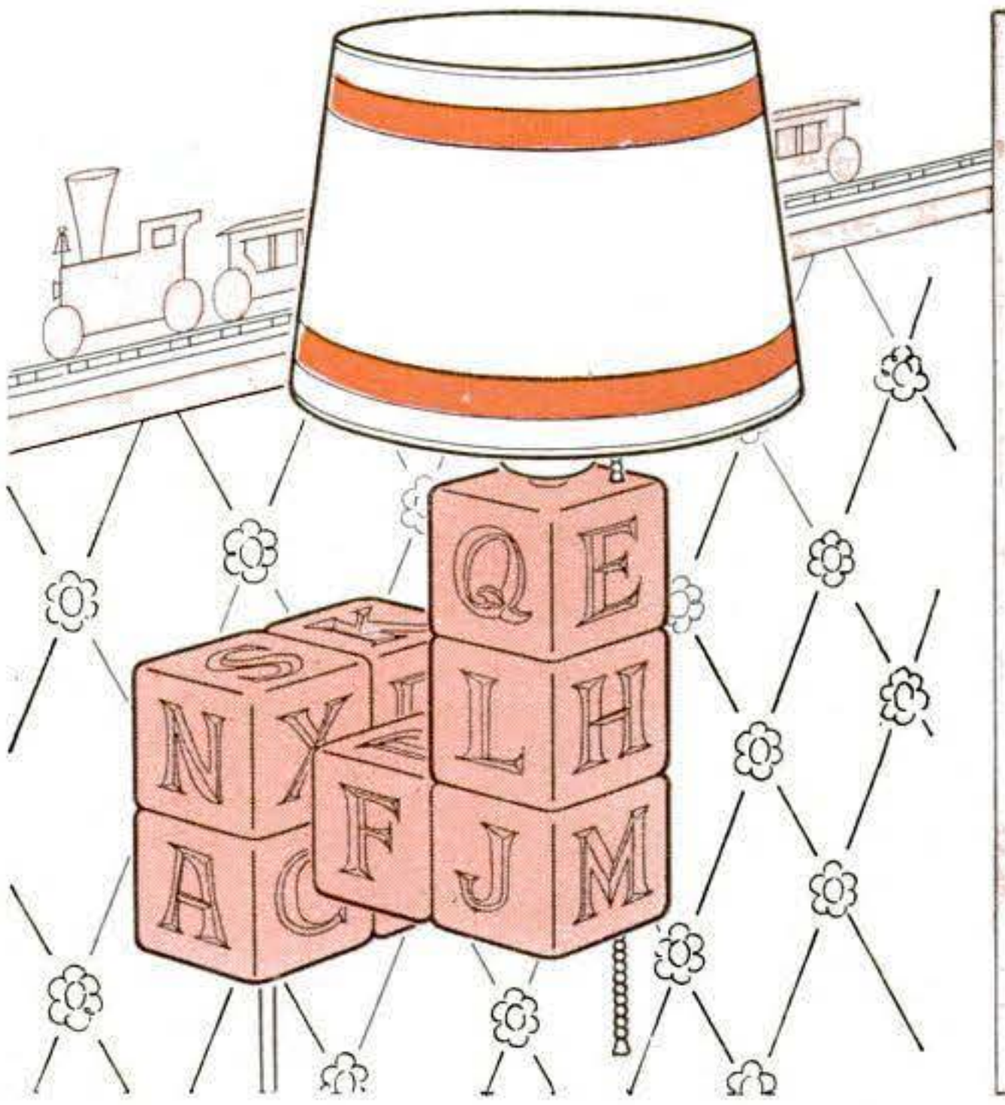
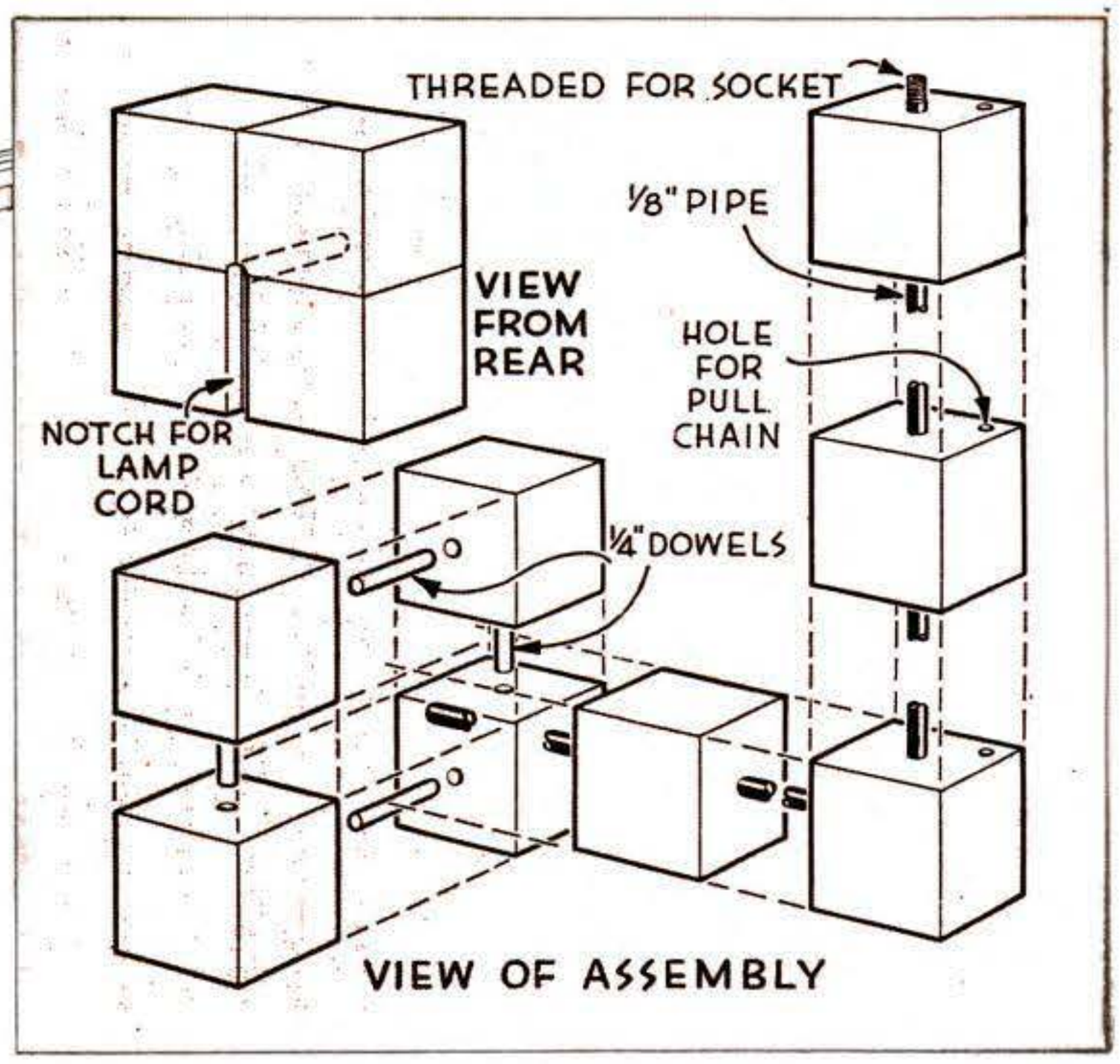
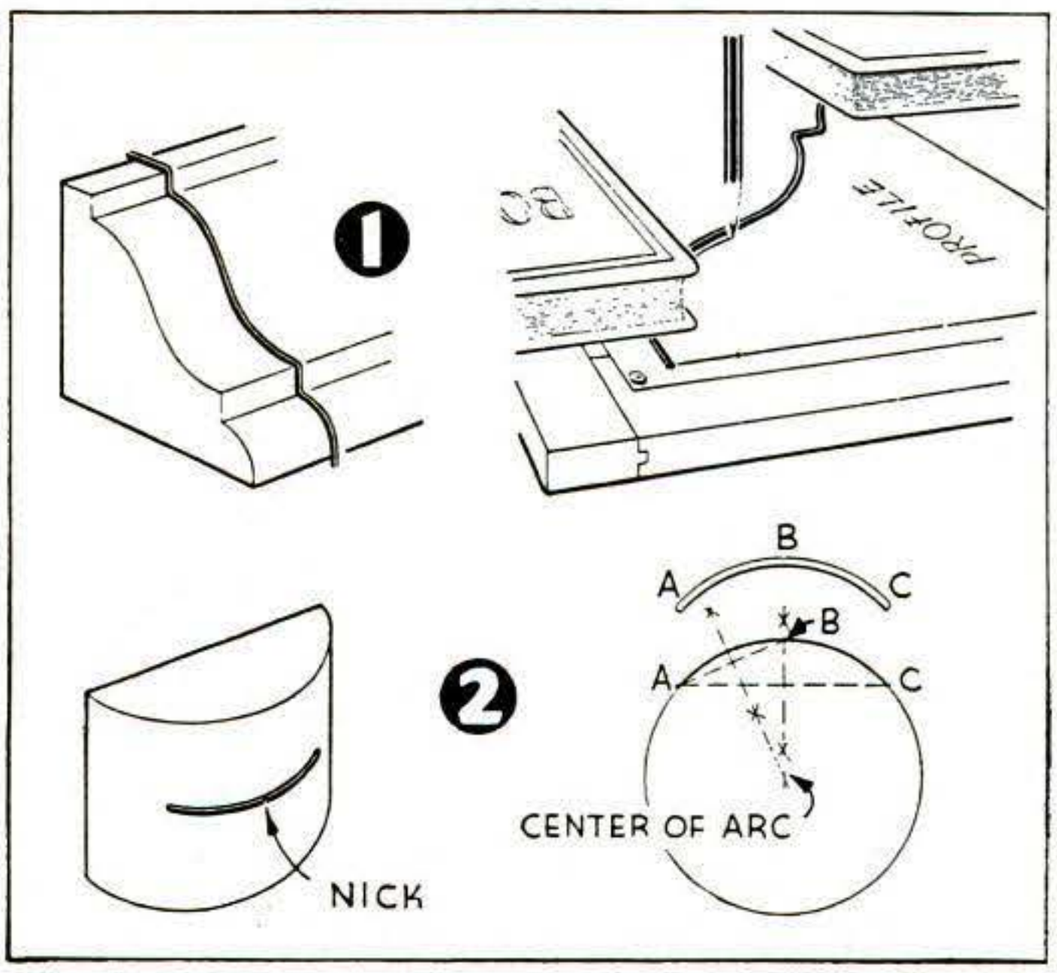




Wall Lamp of Alphabet Blocks Illuminates Child's Room

AS APPROPRIATE as it is easy to make, a wall lamp of ordinary alphabet blocks is a colorful fixture for a child's room. Bevel one edge of two of the blocks in the base to form a notch for the cord which extends to an outlet in the baseboard. Assemble the four with dowels, as shown, and when the glue has set, bore through the center of the assembly for one of the 1/8" pipes. Bore three of the other blocks through for pipe and one halfway through from two adjacent faces. The pull-chain hole is bored while the arm is temporarily assembled.

Thread the cord as the blocks are assembled and glued. Mount the base on the wall with two screws driven through countersunk holes, and plug the holes with plastic composition wood.—PETER WINCZE.



Solder Wire Serves as Guide for Outlines in Drafting

RESIN-CORE solder wire, which is pliable and yet is stiff enough to hold a shape unsupported, is a handy aid in transferring an irregular contour to drafting paper. Press the wire to the contour, as in Fig. 1, and then lay it on the paper and weight the ends. Draw the outline lightly or dot it and fill in later.

To obtain the radius of a partial sphere or cylinder, nick the center of a length of solder wire, mold it on the curve, and mark the center and ends on paper (Fig. 2). Then find the intersection of the perpendicular bisectors of two chords through the three points.—JAMES H. CARLISLE.

Calendar Mounted on Fountain-Pen Cap for Ready Reference

WHEN dates must be referred to frequently, a small calendar will be found handy if it is attached with transparent cellulose tape to the cap of a fountain pen. One month may be mounted at a time, or a full 12-month calendar can be used, the tape removed and months peeled off as they pass, and the calendar remounted.—H. GIFFORDS.

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Mystic "Spirit" Board Spells Out Messages

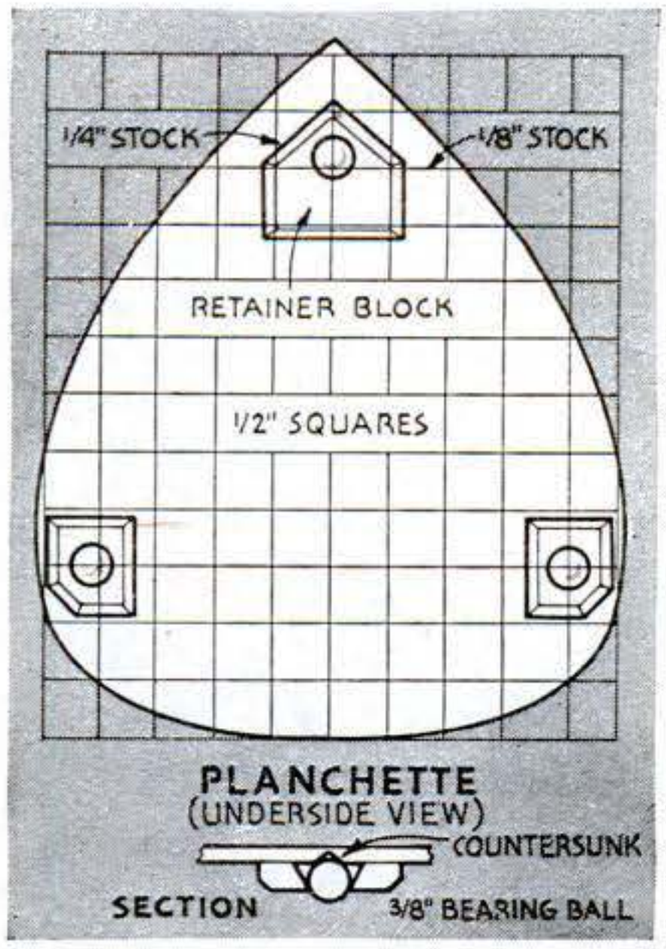
THE subconscious mind is said to be the guiding force behind operation of the ouija board, which is believed to have first made its appearance around the middle of the last century during a wave of spiritualism. Two persons sit beside the board, their fingers resting on a "planchette" and their arms unsupported. Soon the planchette begins to move, and eventually it comes to rest pointing at a letter on the board. Often it will spell out a word.

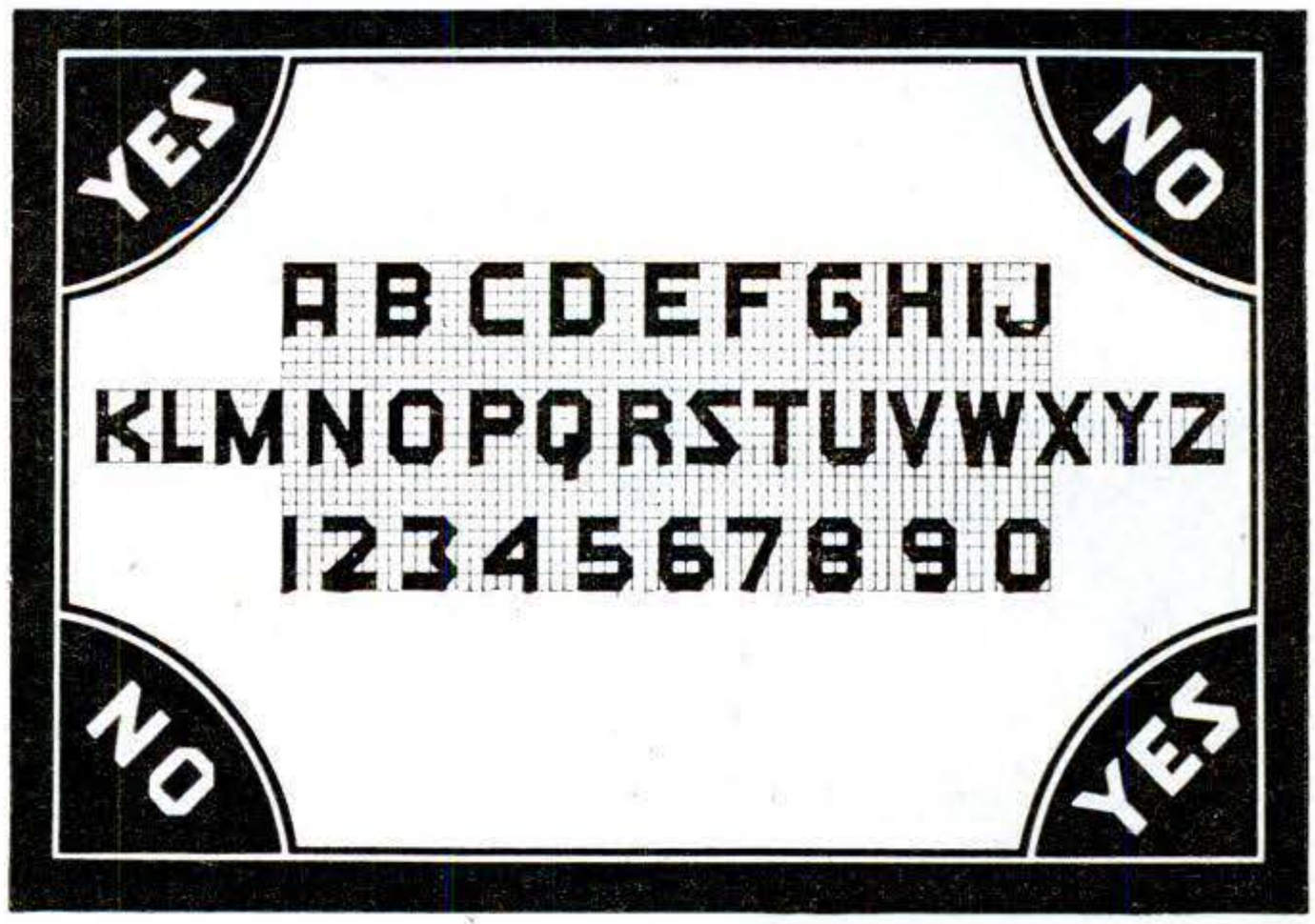
What really happens, according to Dr. Robert S. Woodworth, professor emeritus of psychology at Columbia University, is that muscular tension in the arms sets the planchette in motion. It may come to rest at first on any letter just by accident, or subjective expectancy on the part of one or both of the players may guide it. This first letter may then suggest a word that the players may finish spelling out without realizing that their act is subconscious. The fact that four hands apply pressure in different directions helps create the illusion of independent movement.

A simple ouija board for providing entertainment at parties can be made from a 16" by 24" sheet of stiff cardboard lettered on ¼" squares as shown in the drawing, or you can use plywood of the same size. Letter cardboard with India ink for a black-and-white finish, or use show-card colors having a sharp contrast; then apply a coat of clear lacquer or varnish to both sides. Be sure to put the coat on both sides so the cardboard won't curl. If you use plywood, sand it lightly, use oil paints, and finish with lacquer or varnish. Avoid water stains that may raise the grain and spoil the smoothness essential for easy movement of the planchette.

This planchette, or pointer, is made of wood or pressed composition board, as indicated in the drawing. The retainer blocks, which act as bearings for the steel balls, should be hardwood. A countersunk hole in the board over each ball helps to make movement smoother.

In using a ouija board, the two players put both hands on the planchette and wait for muscular tension to cause it to move. Sometimes, in the midst of a semiserious session, laughter can be provoked if you are skillful enough to guide your partner's hand to letters that provide a comical answer to some spoken question.





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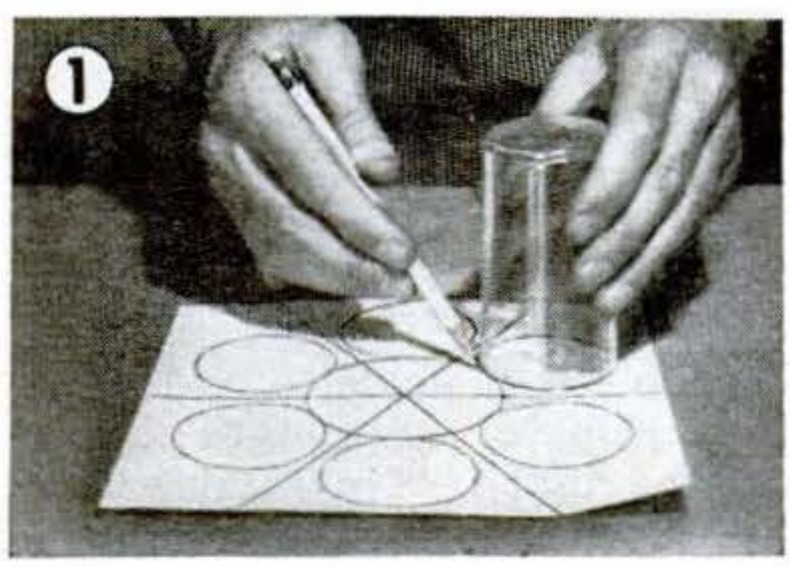
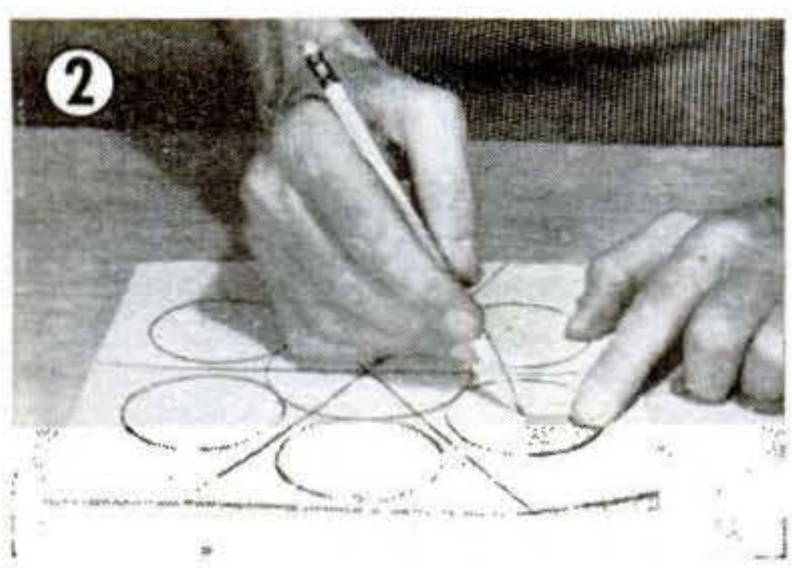
Beverage Server

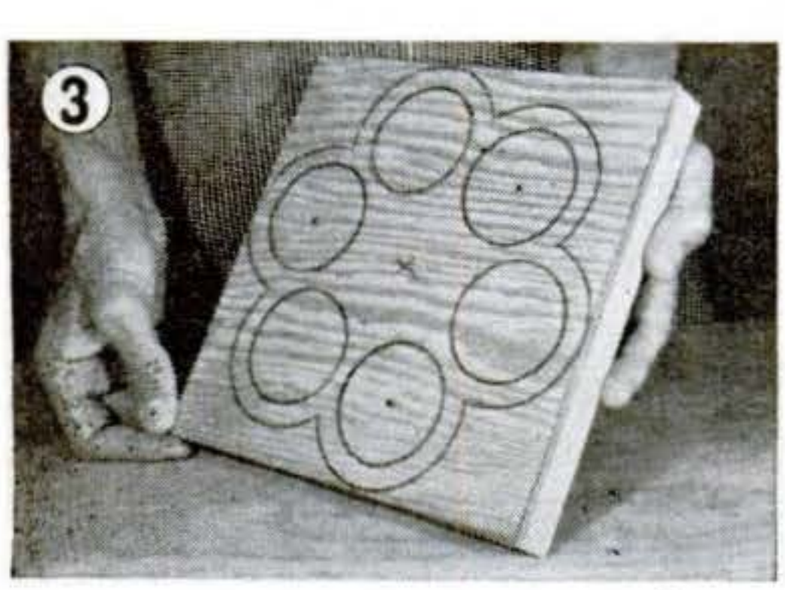
Guests will find it hard to believe that you could make such an attractive beverage server merely from scraps and a piece of broom handle. Recesses like those to hold the glasses usually require routing, but by making the tray section in two parts, you can cut them with a simple saw



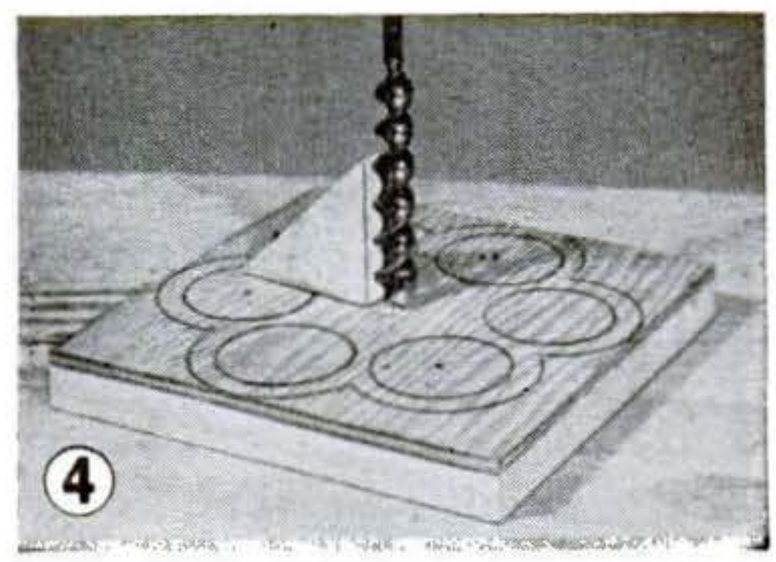
Lay out a pattern for the tray first, using one of the glasses it will hold. Cross three lines at equal angles for a six-glass tray, place a glass upside down ¼" from adjacent lines, and draw a circle around the glass. Draw a central circle just touching the first one



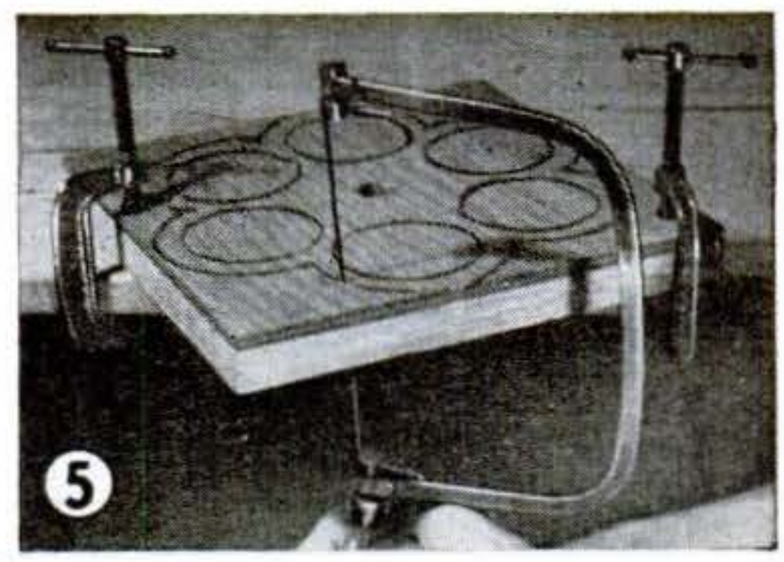
Use the glass again, and draw rings tangent to the central circle and ½" apart. Locate the centers of these rings with a disk or a segment of the same radius, and from these centers draw arcs on a radius ½" larger than that of the rings. A compass will be needed



Nail together near the corners two squares of wood, one ¼" thick and the other about ⅝". Transfer the design to the thin piece, using carbon and taking care to locate the center. Drive nails lightly in two or more rings so the pieces won't part as the outline is cut

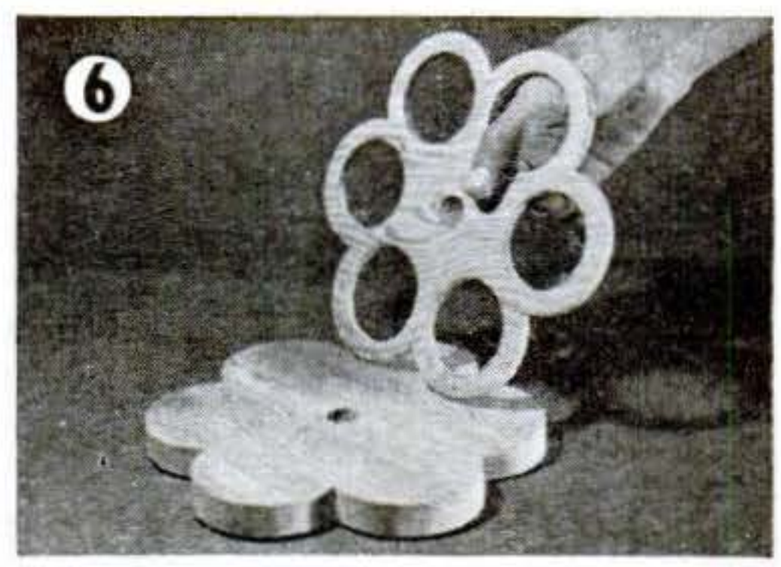


Bore a hole at the center for a tight fit for the broomstick or a length of dowel. This should be perpendicular to the surface of the tray, so nail a right triangle of wood lightly to the stock to act as a guide for the bit



Using a coping saw, cut the outline through both pieces of stock at the same time. A convenient way to do this is to clamp the work firmly to a table or bench, leaving the part you are cutting projecting over the edge

Separate the two pieces after marking an edge so they can be aligned again, and saw out the circles in the thin section. Start the coping saw through a drilled hole, clamping the piece as before and moving it when necessary



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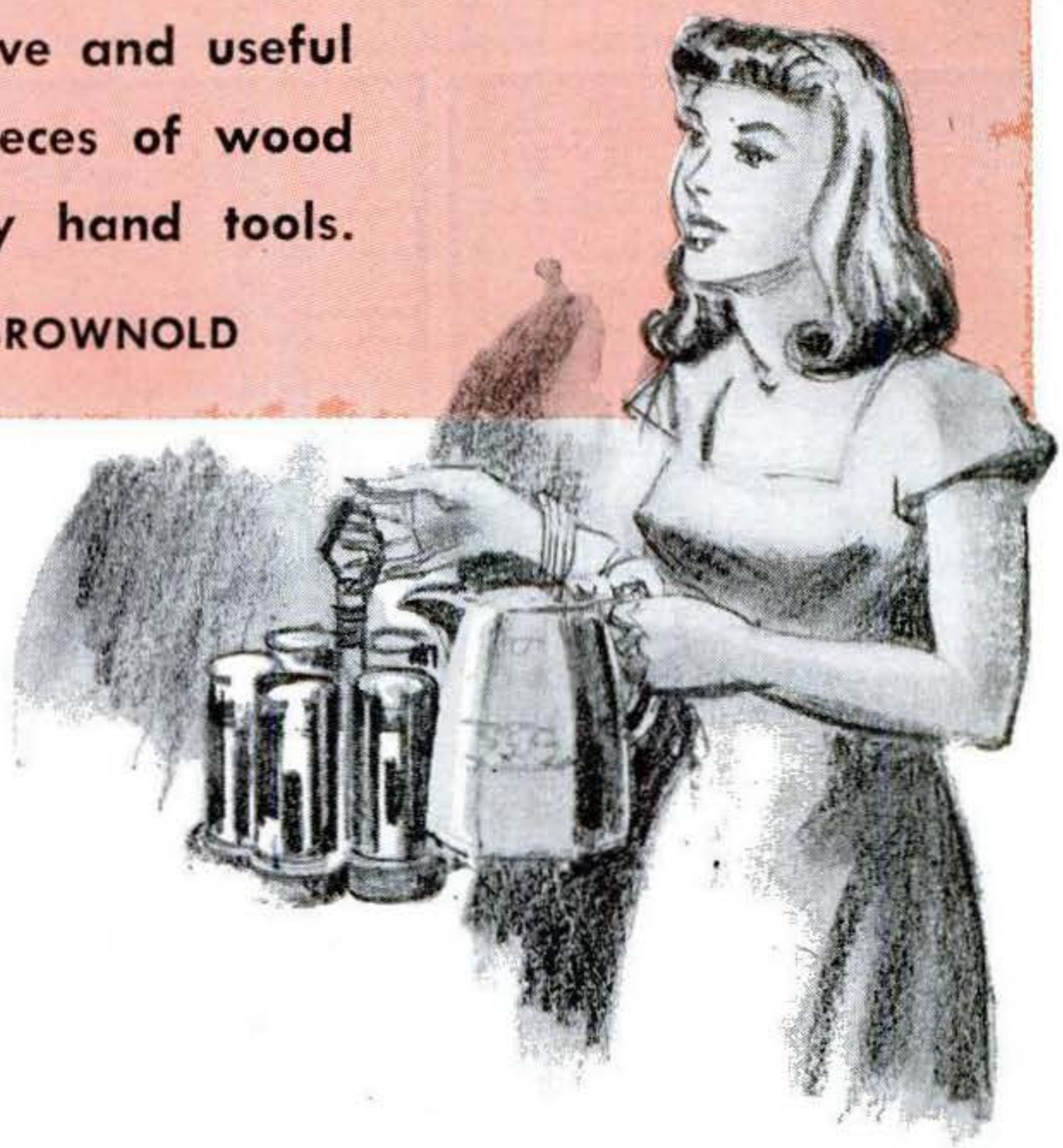
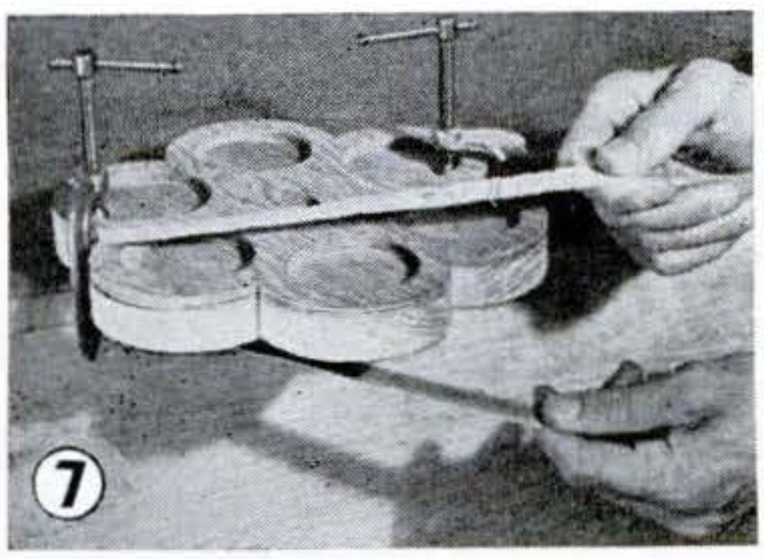
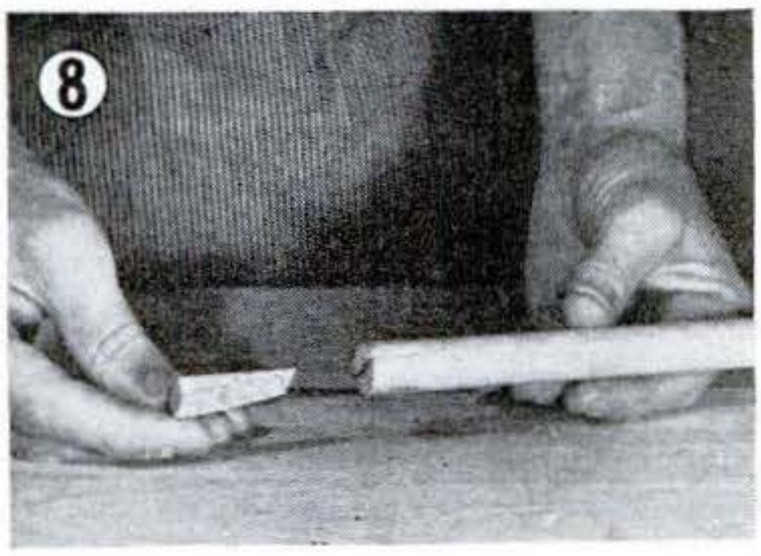
Anyone can make this attractive and useful home accessory from scrap pieces of wood with the simplest of ordinary hand tools.

By CHARLES and BERTRAM BROWNOLD



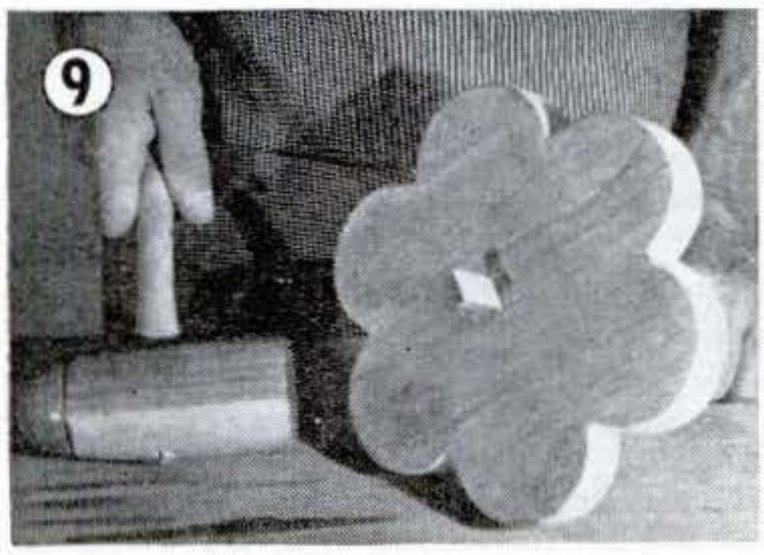


Glue the two sections together, using clamps for pressure and being sure to align the marks at the edge so any slight irregularities in sawing will match. Let the glue dry; then round the edges with a strip of sandpaper

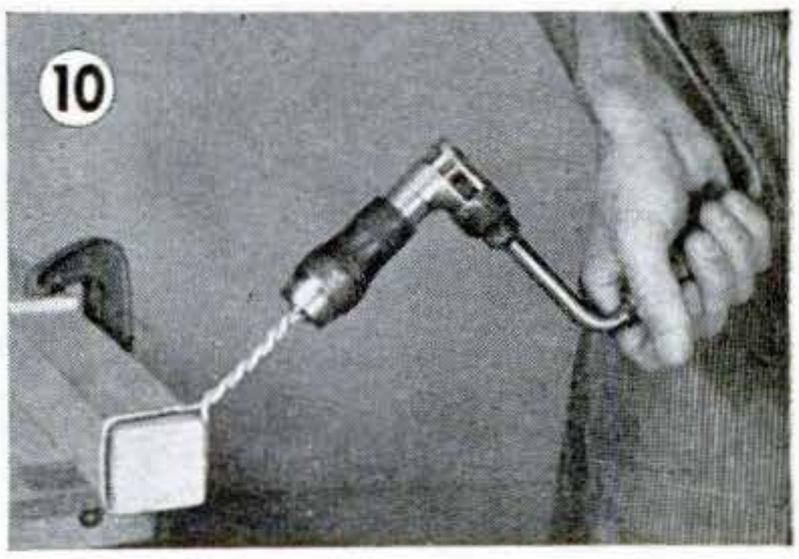


Cut a length of broom handle or dowel a little less than twice the height of the glasses to be used. Square one end, make a saw cut in it, and shape a wedge to fit the saw cut. Round off the other end of the handle slightly

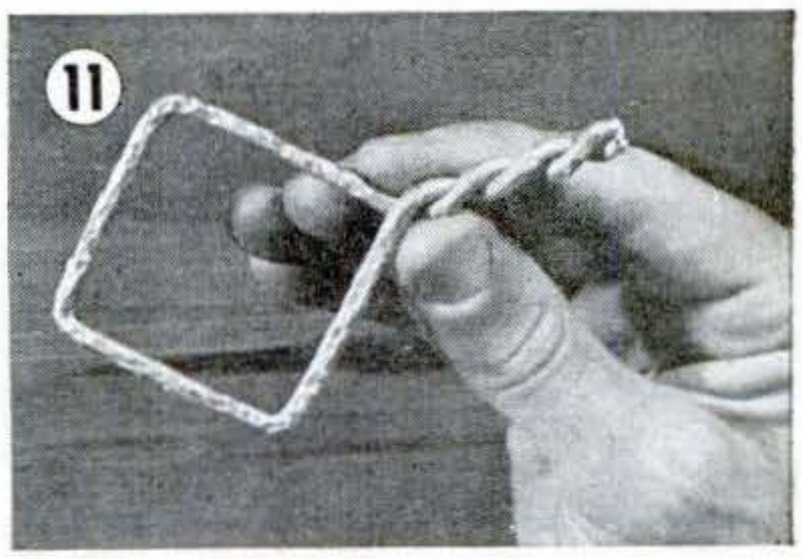
Glue the broomstick into the hole in the tray, drive in the wooden wedge, and when the glue has dried, cut off any of the wedge that protrudes. Sand the bottom smooth. Then paint, stain, or varnish the entire piece as desired



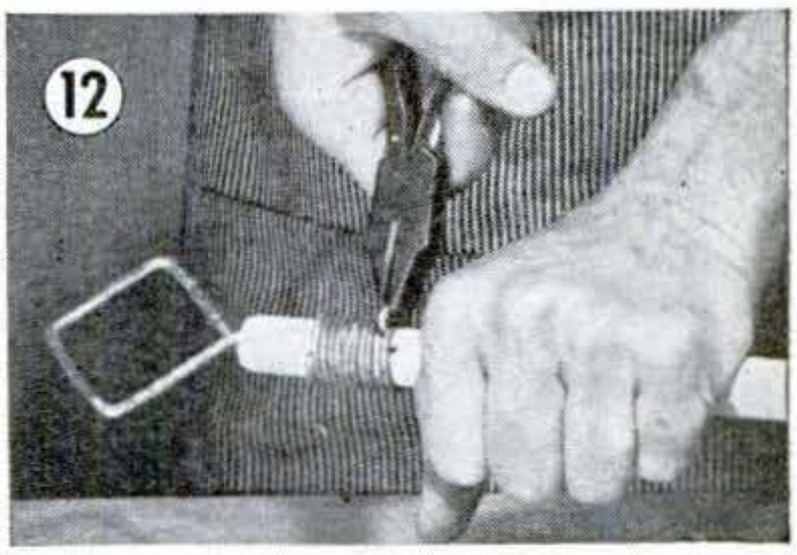
Coat-hanger or heavier wire will make a good handle. Shape it by bending it around the square part of a piece of 2″ by 2″ stock and twisting the ends in a hand brace. Start the twist at the ends and work toward the wood. The ends can then be soldered if necessary



Lay the square of wire on a metal surface or a stone and hammer for an attractive finsh. Drill a deep undersize hole in the top of the broomstick and force the wire in, twisting as you would a screw to help form threads. Cement in the hole may help to hold the wire



For added decoration, hammer another length of wire and coil it on the upper part of the handle. Tuck the two ends in holes drilled to receive them. Coat both wires with clear lacquer to keep them from rusting. The tray should then be touched up if it is necessary



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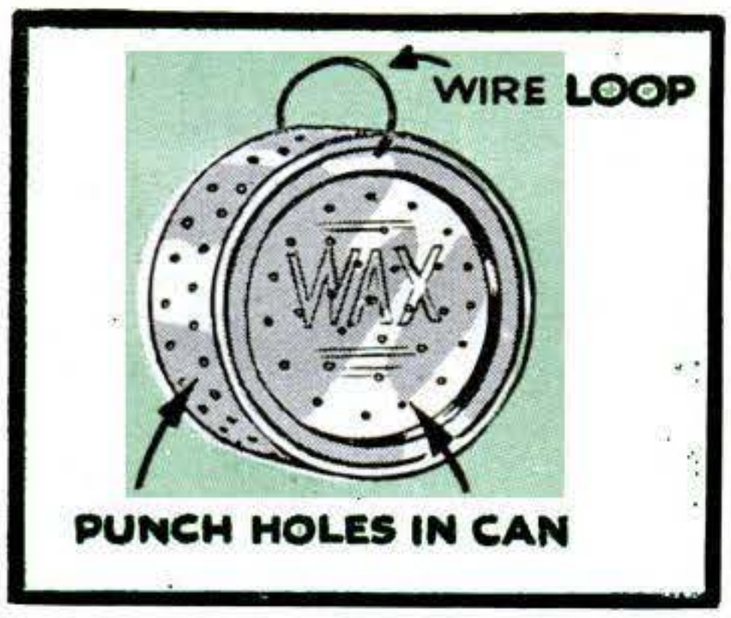
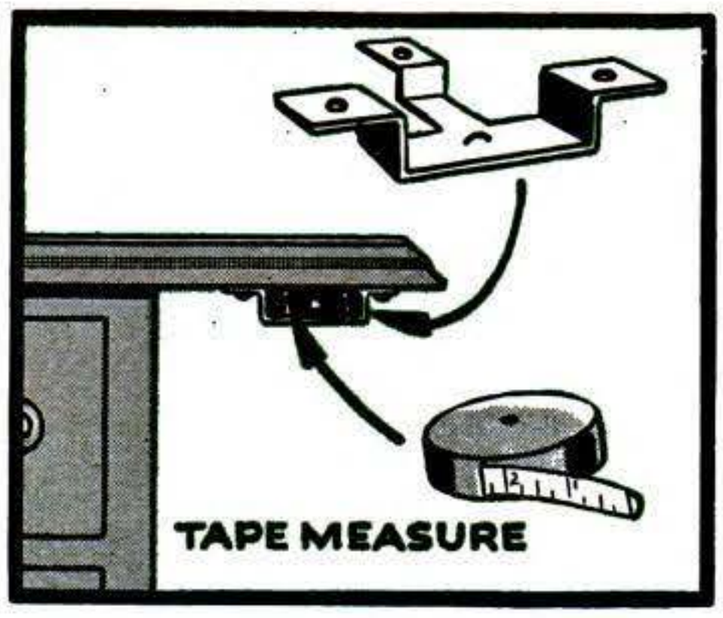
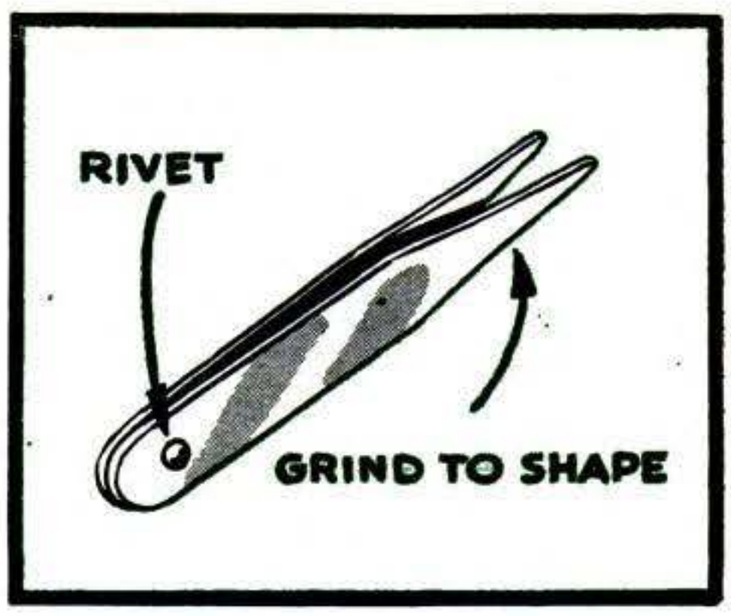


Empty wax cans, punched full of holes, are handy as containers for hanging moth balls in closets

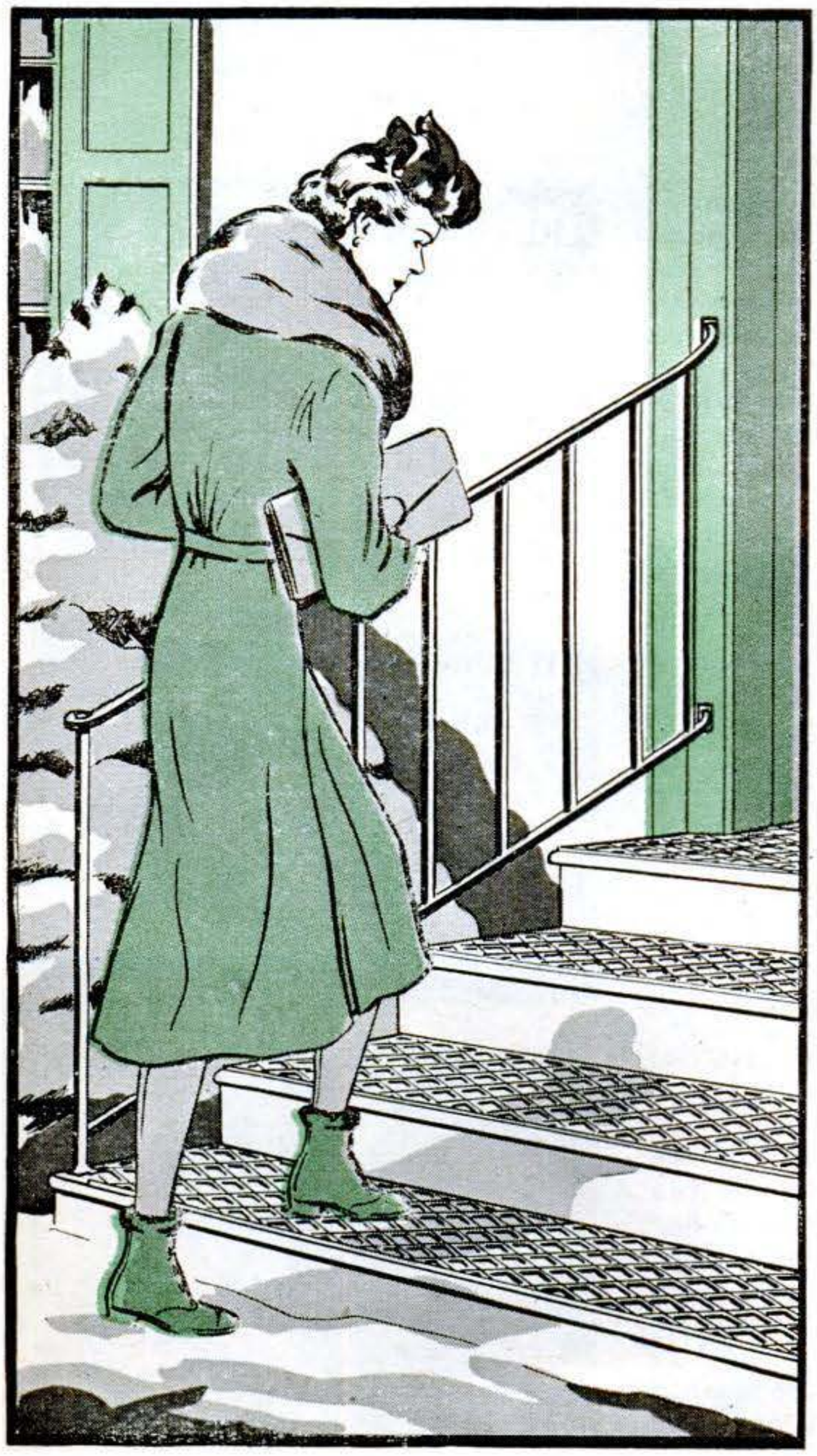


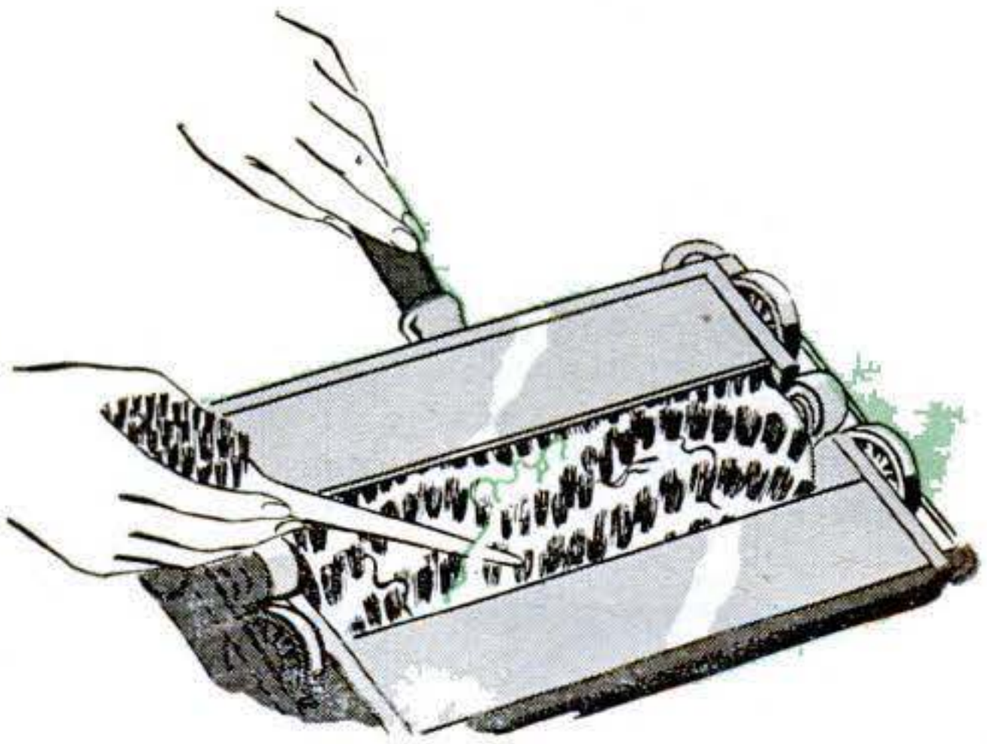
A tape-measure rack of tin-can stock or thin strap iron is a convenience on a sewing machine



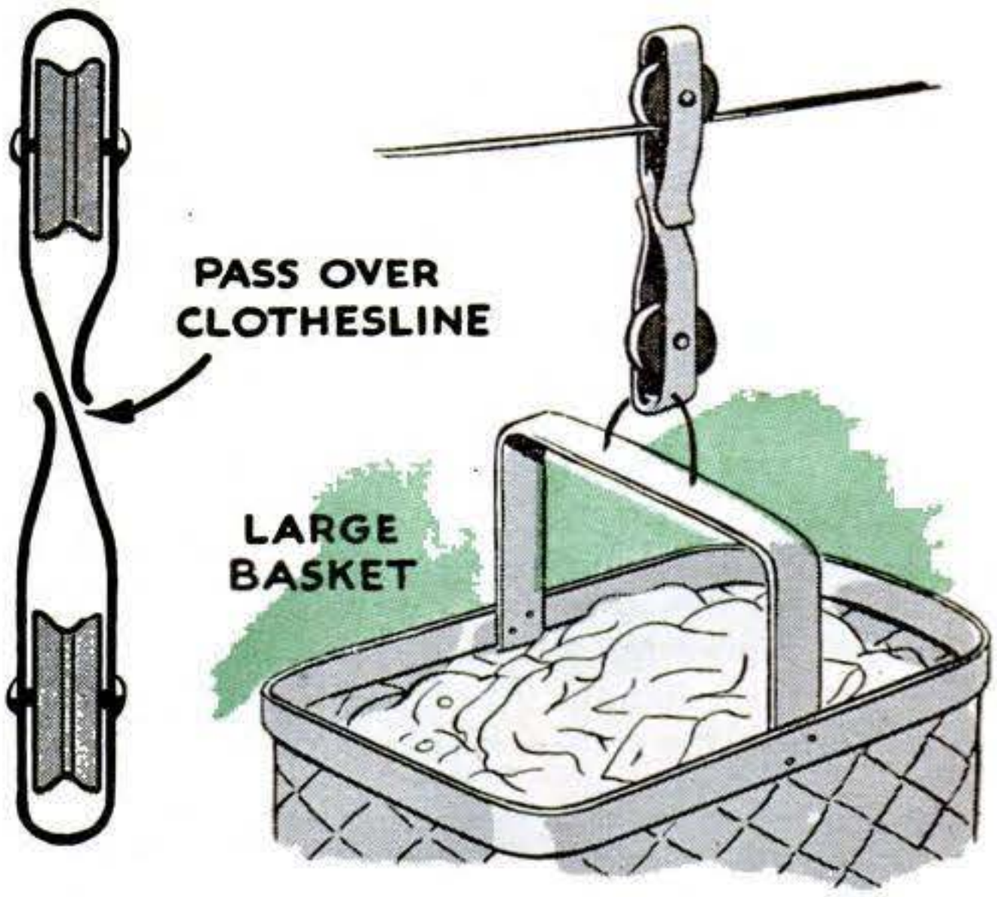
Two pieces of old hacksaw blade ground, riveted at one end, and sprung apart, make good tweezers

Wire-type lath, cut to fit on your entrance stairs, will serve as safety treads during a snow or in icy weather. Hold them with small staples at the ends, or at front so the backs can be raised for sweeping





Use the handle of a rattail brush or comb, or a handle whittled to a point, to take strings off carpet-sweeper rollers. The brush removes lint



Slipped on a fixed or double-pulley clothesline, a line separator will hold a big market basket of wet wash. It can be slid along a fixed line or kept stationary on a line working on pulleys

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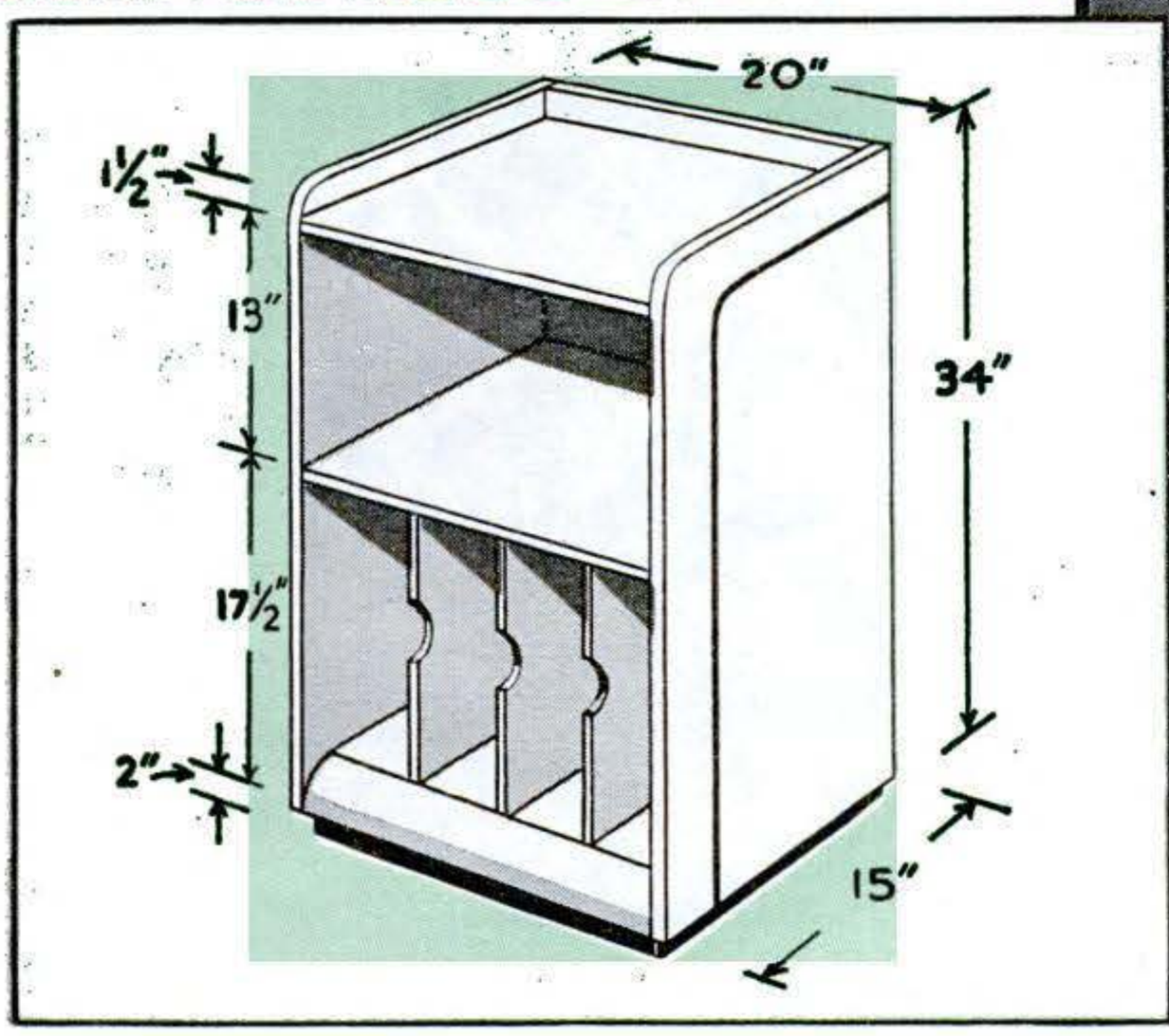
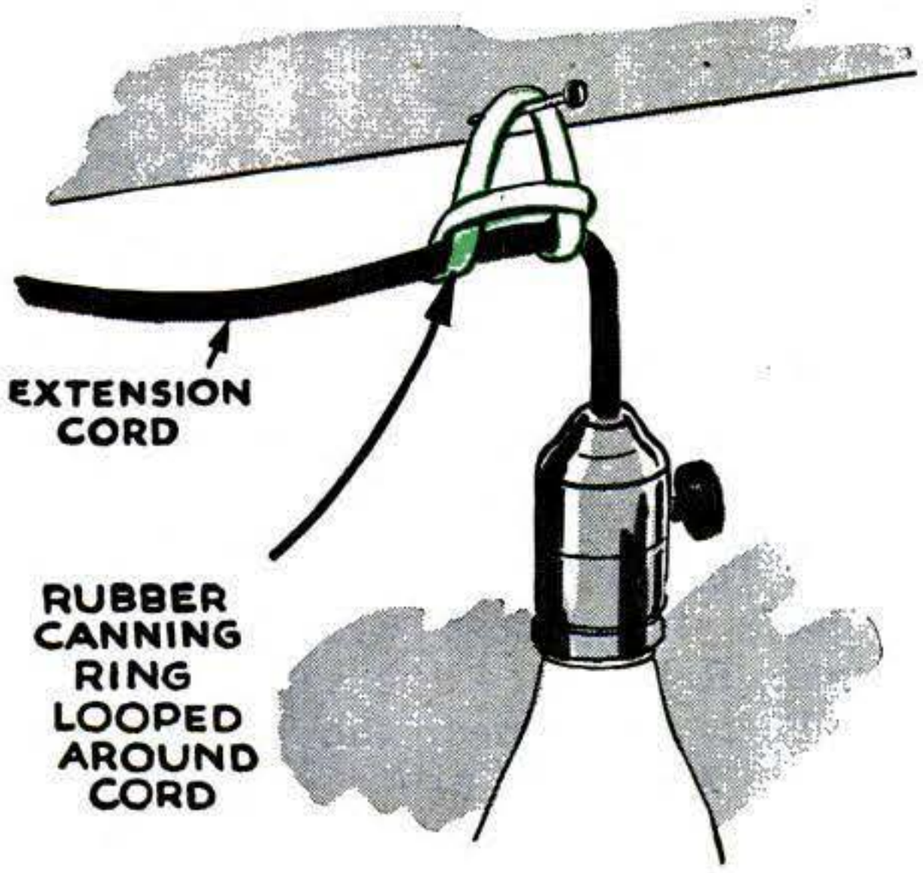
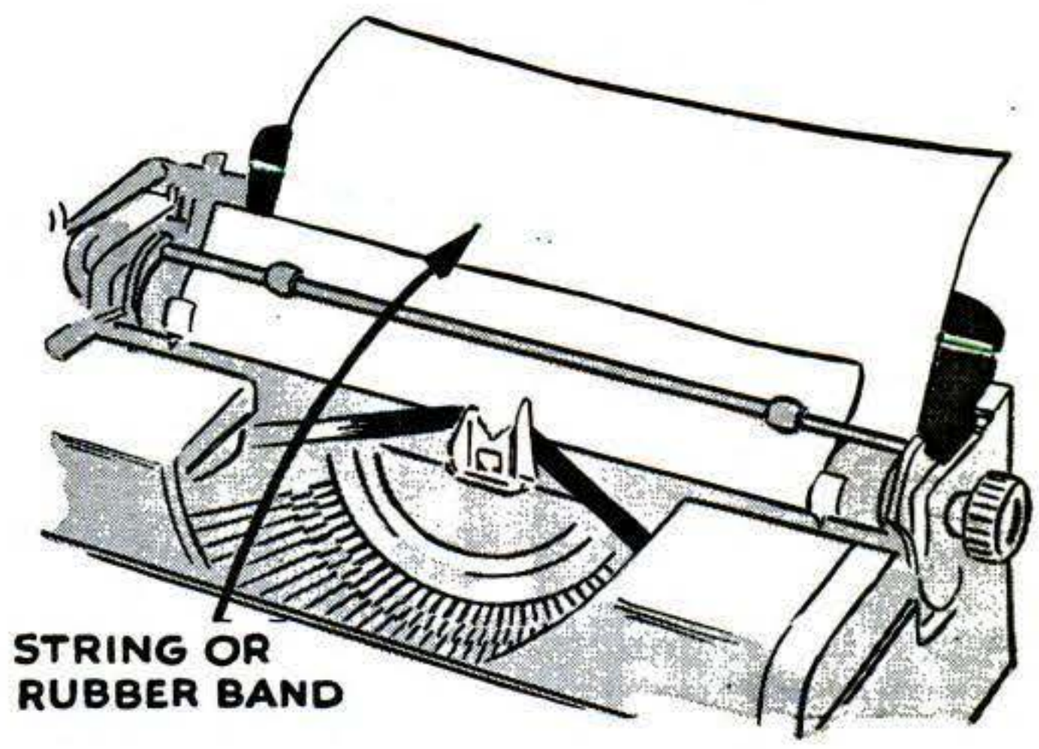
SHORTCUTS



You can start your record collection with a cabinet like this, using the empty spaces for magazines until albums displace them. A dozen large albums or 40 individual ones—some 250 records—can be accommodated. Finish with a good enamel. Note the recessed pedestal base





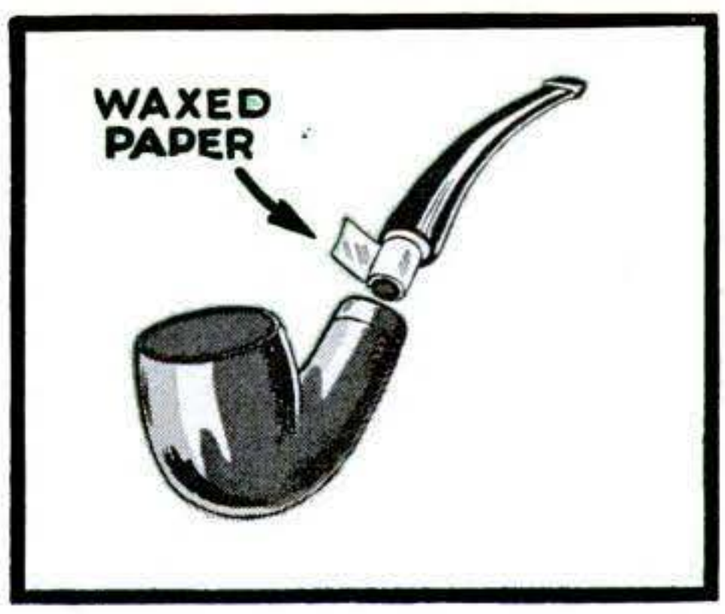
When you next need to hang an extension cord on a nail to light a dark corner, try looping a rubber canning ring on it to keep the cord from slipping

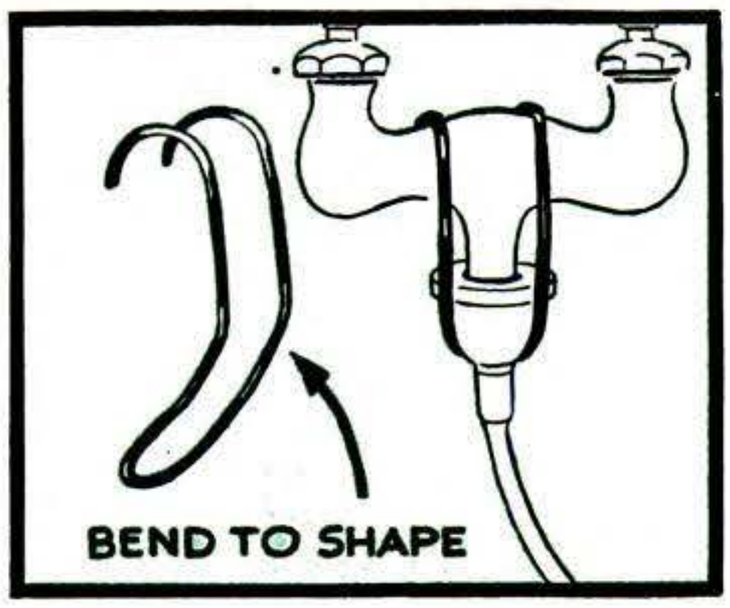
If the bottom half of a sheet of paper blows over your typewriter keys, anchor it with a rubber band attached as shown and insert the paper behind it

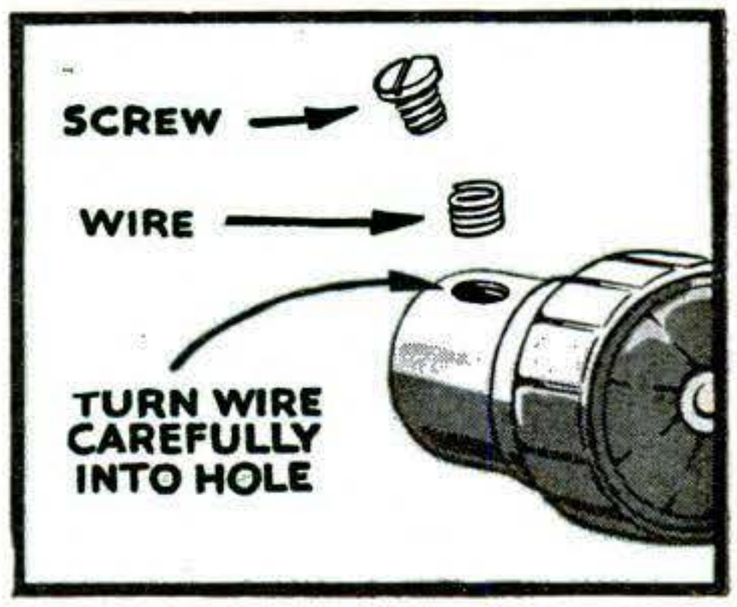
Waxed paper as a bushing on a pipe stem will not swell and split a shank. It lubricates so the stem may be pulled out

Coat-hanger wire, bent as shown below, will keep water pressure from forcing your shower-hose coupling off the bathtub faucet

Wind a fine wire onto a screw that won't hold in a plastic knob. Carefully unscrew the coil, turn it into the hole, and insert screw







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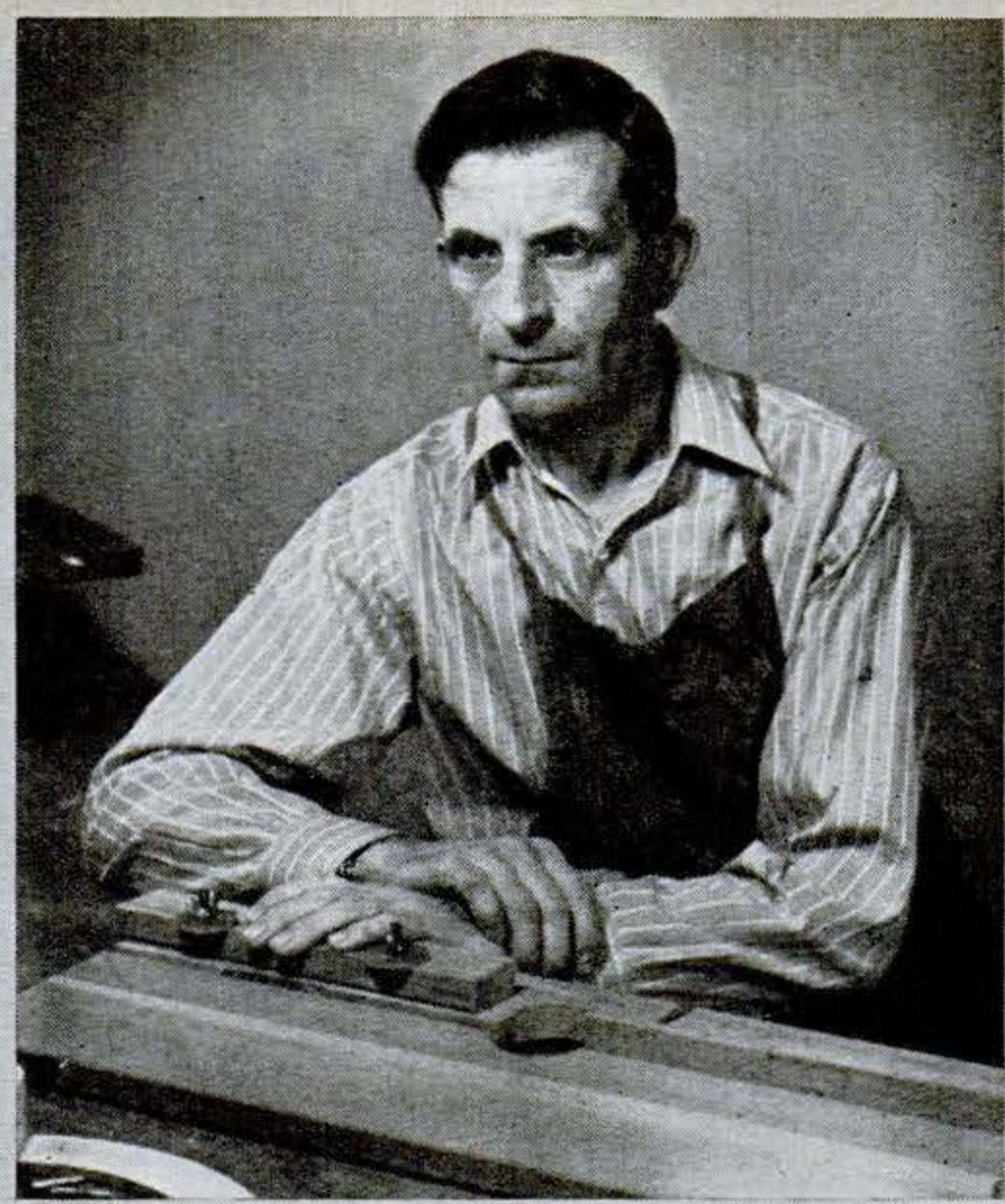
Meet

EDWIN M. LOVE

FOR more than 18 years Edwin M. Love has been writing "how-to-make" articles. In his own words, "With the exception of time out for occasional excursions into writing and illustrating children's books (not all of which have been published!) and, recently, a tour of duty in a defense plant, preparing these articles has been a full-time job and hobby rolled into one. However, on the rather rare occasions when I have a little time to myself, I dabble in the field of good music."

Mr. Love lives in Palmdale, Calif. He has made a specialty of woodworking projects — furniture, models, novelties, and the like. He is particularly interested in describing new shop methods. Jigs and forms, he feels, should be adaptable and permanently useful. Such articles as the one below illustrate his point. Here you will find jigs that are well worth the time spent in making them because they will prove useful over and over again



Jigs Speed Reconditioning of Circular Saws

By EDWIN M. LOVE

USE of a file in the jigsaw takes the guesswork out of sharpening combination and planer saw blades. A jig for this purpose is not difficult to build, and it can be used time and again.

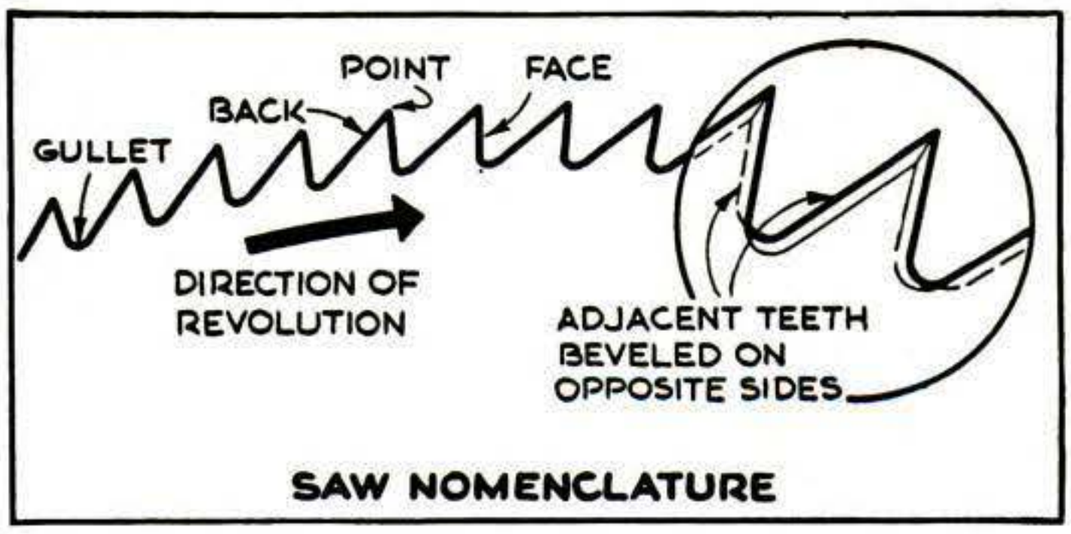
The jig is not foolproof. Use of it to good advantage does require judgment, but it can hardly be said to call for a great amount of skill. With it the novice can do excellent work. The hook and bevel angles of the saw teeth will not vary after sharpening, and uniform tooth length will be the rule.

About the only pitfall to be watched for is the chance of filing the teeth on one side of the saw blade shorter than those on the other; but tooth shape and spacing will be much more nearly perfect than is the case when sharpening is done by hand filing.

Jointing of a blade is not absolutely necessary every time the teeth are sharpened, but it is useful for matching the lengths of teeth when alternate teeth are filed and a change of setup is required. Setting is necessary for flat blades but not for hollow-ground blades.

How is a blade jointed? Mount it backwards on the saw arbor with the maker's trade-mark uppermost when the nut is tightened. Remounted the same way after having been sharpened, the blade will be concentric with the arbor even in cases where the arbor hole is oversize. Raise the table until the teeth barely rub an oilstone rested on the table above the blade opening, and run the saw for a few seconds. Examine the teeth to see that a small, bright flat spot or "shiner" appears at each point. If this shiner does not show on every point, start up the saw again and hold the oilstone to the teeth for a few more seconds.

Is setting difficult? Not with the jig illustrated. The drawing on the facing page shows its construction. To use it place a



SAW NOMENCLATURE

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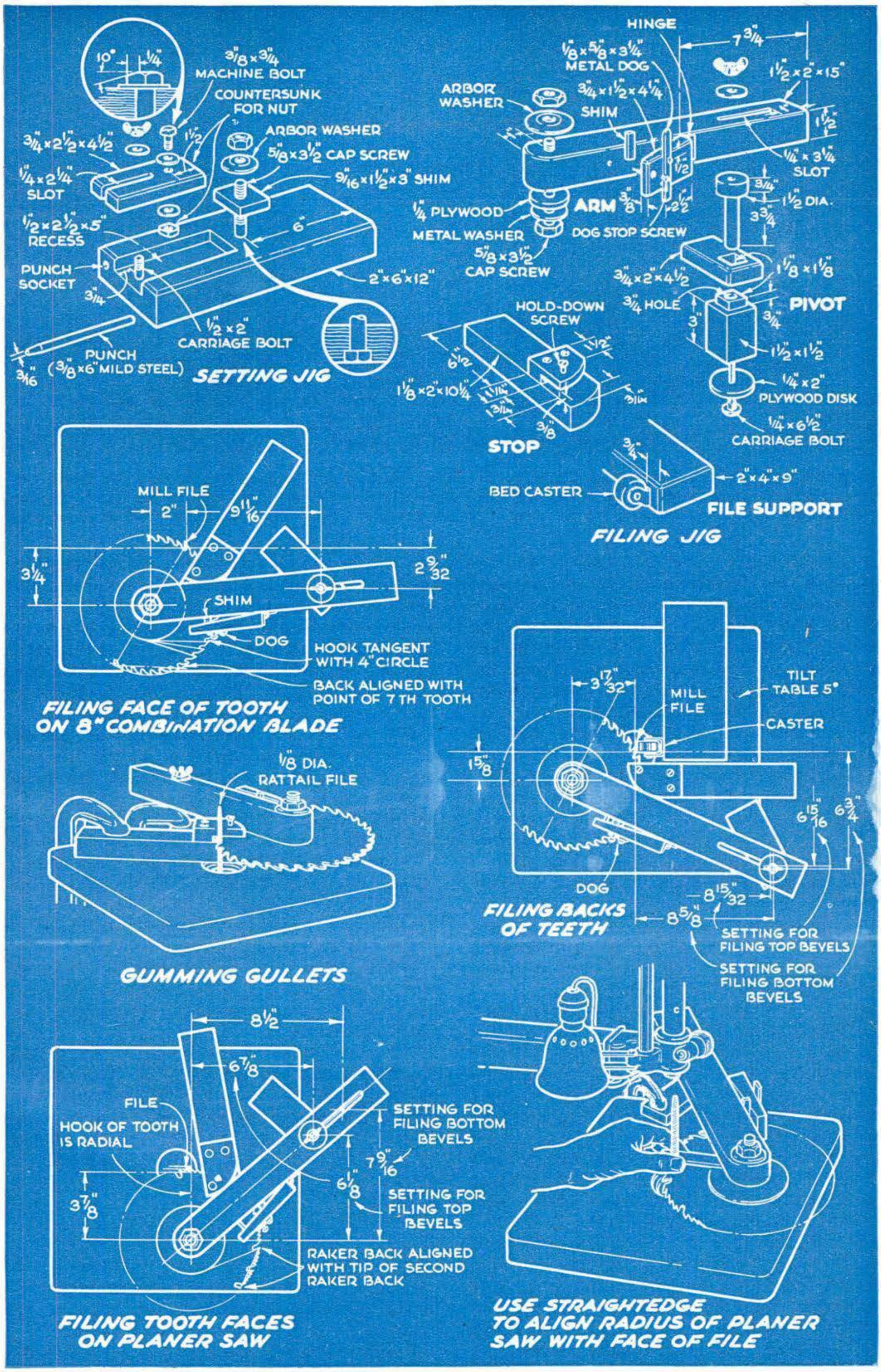

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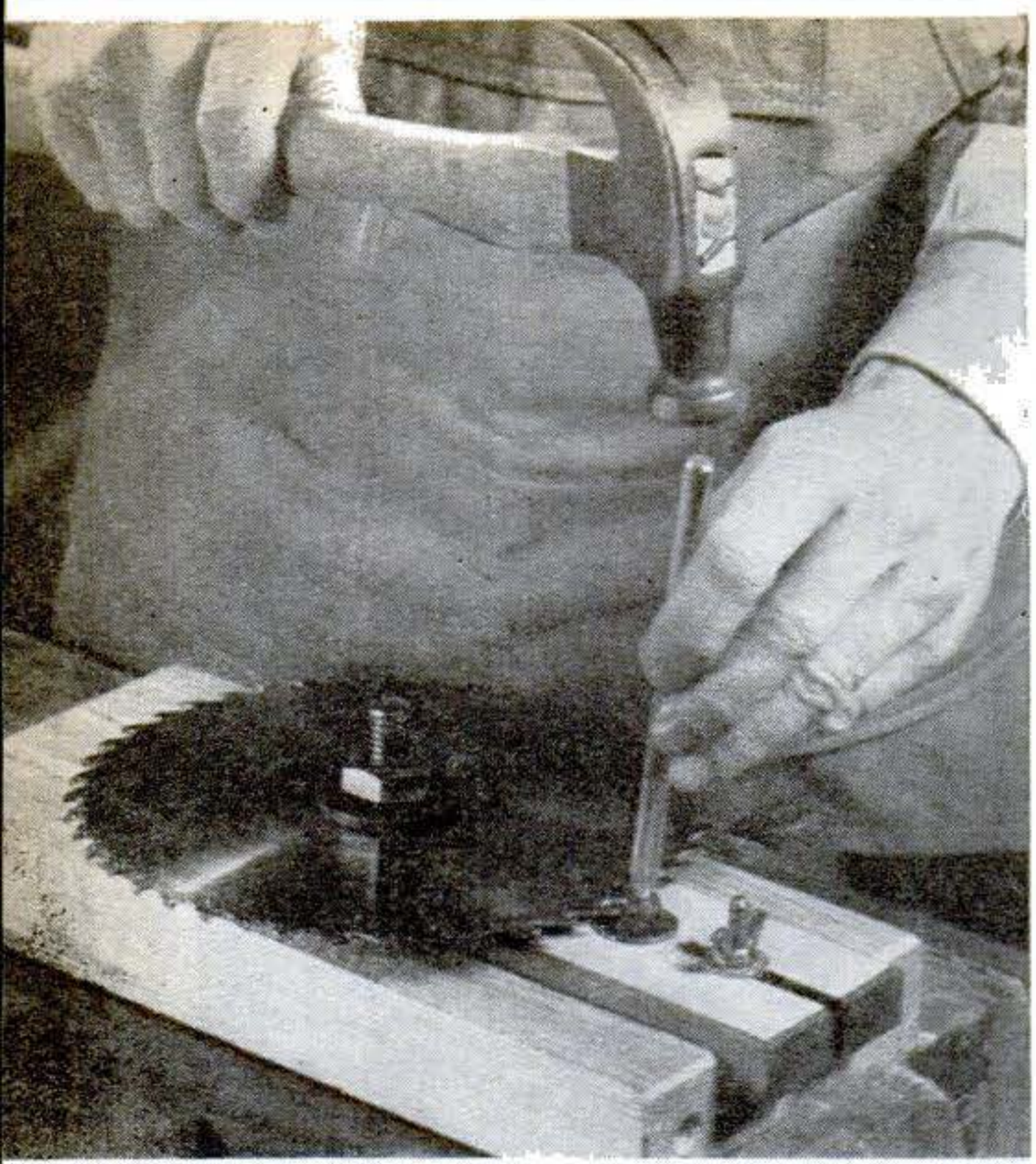
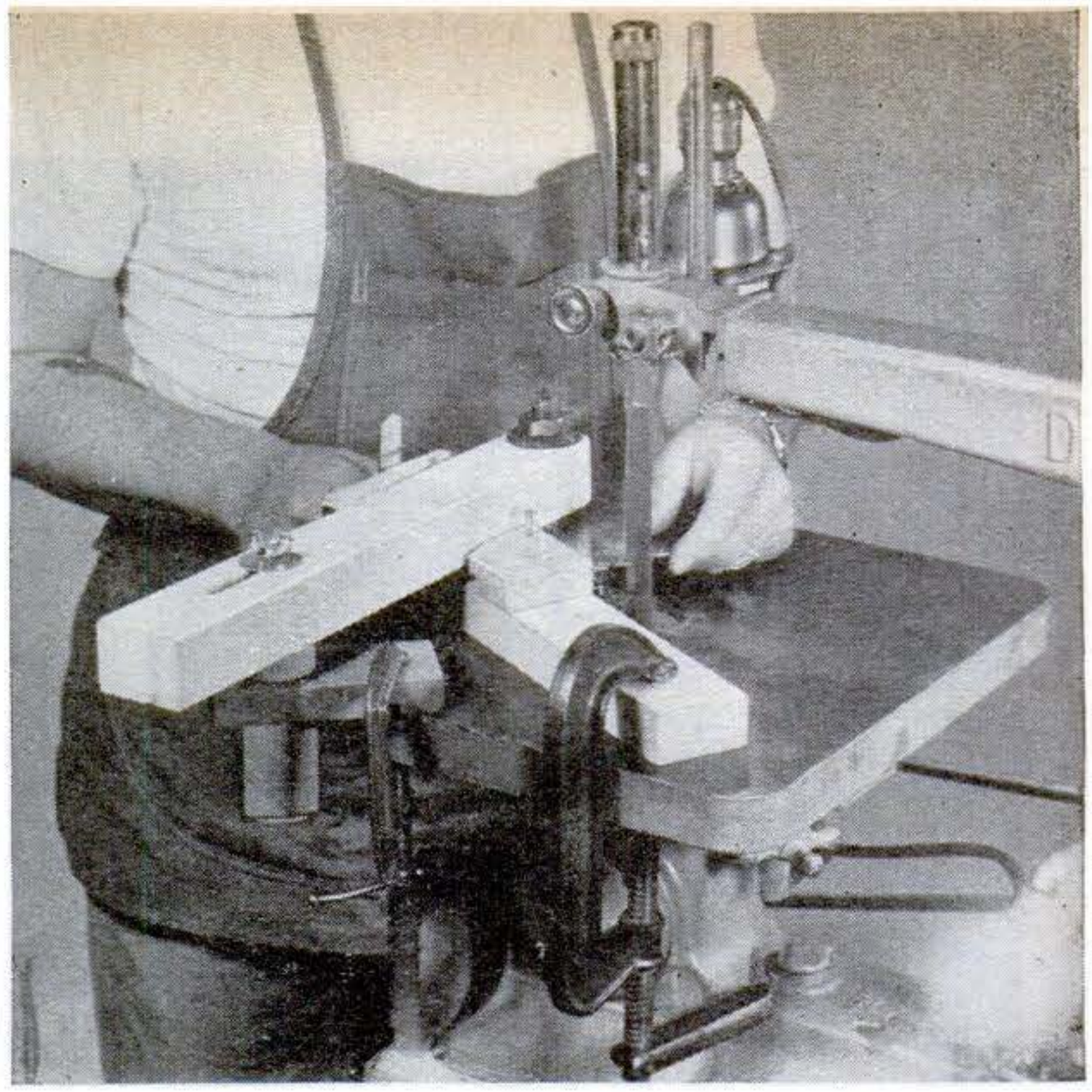


Setting the teeth of a circular-saw blade is simple with a jig like this. Set alternate teeth to one side; then turn the blade over



In filing the face of the teeth, go around the blade two or three times with very light cuts if the teeth appear to be irregular. This tends to space them more evenly

wooden shim of proper thickness on the arbor cap screw, which should be of the same diameter as the saw arbor; slip on the blade and nut, and rotate a downward-set tooth over the stake. Adjust the stake to set the tooth for a distance of ⅛″ from the point, and set with a light hammer blow. Skip the next tooth and set the second, and so on. Then turn the blade over and set the remaining teeth.

What is the filing jig? Its construction is also shown in a drawing. The arm is slotted at one end for adjustment on the pivot, and on one side it has a hinged and tapered leaf carrying a metal dog. For a pivot bearing a block is tenoned to glue into a horizontal block which is used in clamping the bearing to the table. A through bolt holds the bearing together and secures the pivot to the arm. Forward motion of the arm is limited by a stop block.

How is a combination blade sharpened? To file the faces of the teeth, level the jigsaw table and insert a round-edge mill file in the chuck. A mill file with a square edge can be used if one with a round edge is not available. Set one side square with the front edge of the table.

Mount the blade under the jig arm, clamp the arm to the table, place the stop against it, and turn the hold-down screw on the stop to make contact with the blade. Turn the blade until the face of a tooth bears against the file, open the dog leaf until the dog also touches the face of a tooth, and turn in a wood screw against the edge of the dog for its stop. Then close the leaf slightly, bracing it with a shim, and start up the jigsaw.

Feed the tooth against the file by rotating the blade counterclockwise while holding the arm against its stop. Remove enough metal to true the tooth and to cut the shiner in half. Once the amount of filing is established, draw the arm back and swing the dog out. Rotate to the next tooth, close the dog, and file again. When all the faces have been filed, set up for filing the backs.

Dimensions for a typical setup are given in the drawing, but they are simply for use as a guide. One easy way to get the hook of a tooth right is to remember that it is usually tangent to a circle half the diameter of the blade. If the blade is positioned with about ¼″ of a round-edge file making contact with the face of a tooth, the setup will be correct. There is little spring to the file, and for this reason filing should be continued until cutting stops.

When are gullets gummed? This is done next. Clean out the gullets with a 4″ rattail file, keeping them tangent with the faces of the teeth.

What is the setup for filing backs? Tilt the table 5 deg., and fit the back of the tooth to the opposite side of the file, noting that on most combination saw blades the back of each tooth is aligned with the tip of the seventh tooth behind it. Then, as before, set the metal dog to engage the face of a tooth.

A tooth set upward is beveled on the underside, while one set downward is beveled on top. File alternate teeth. Then draw back the arm of the jig, tilt the table 5 deg. in the opposite direction, reset the arm to bring the file in position, and continue.

How is a planer saw filed? The round-edge mill file is also used for this job. Set

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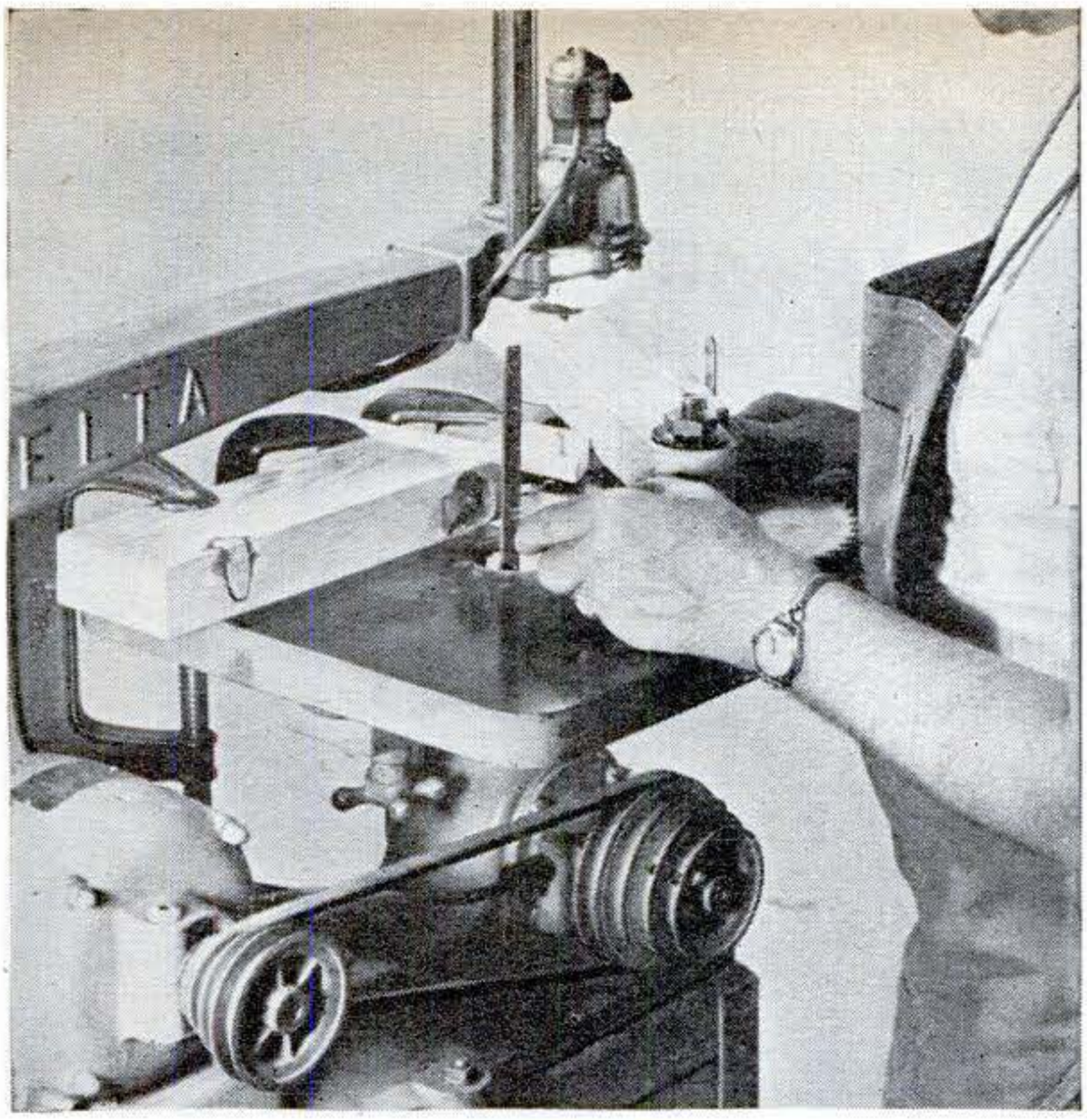
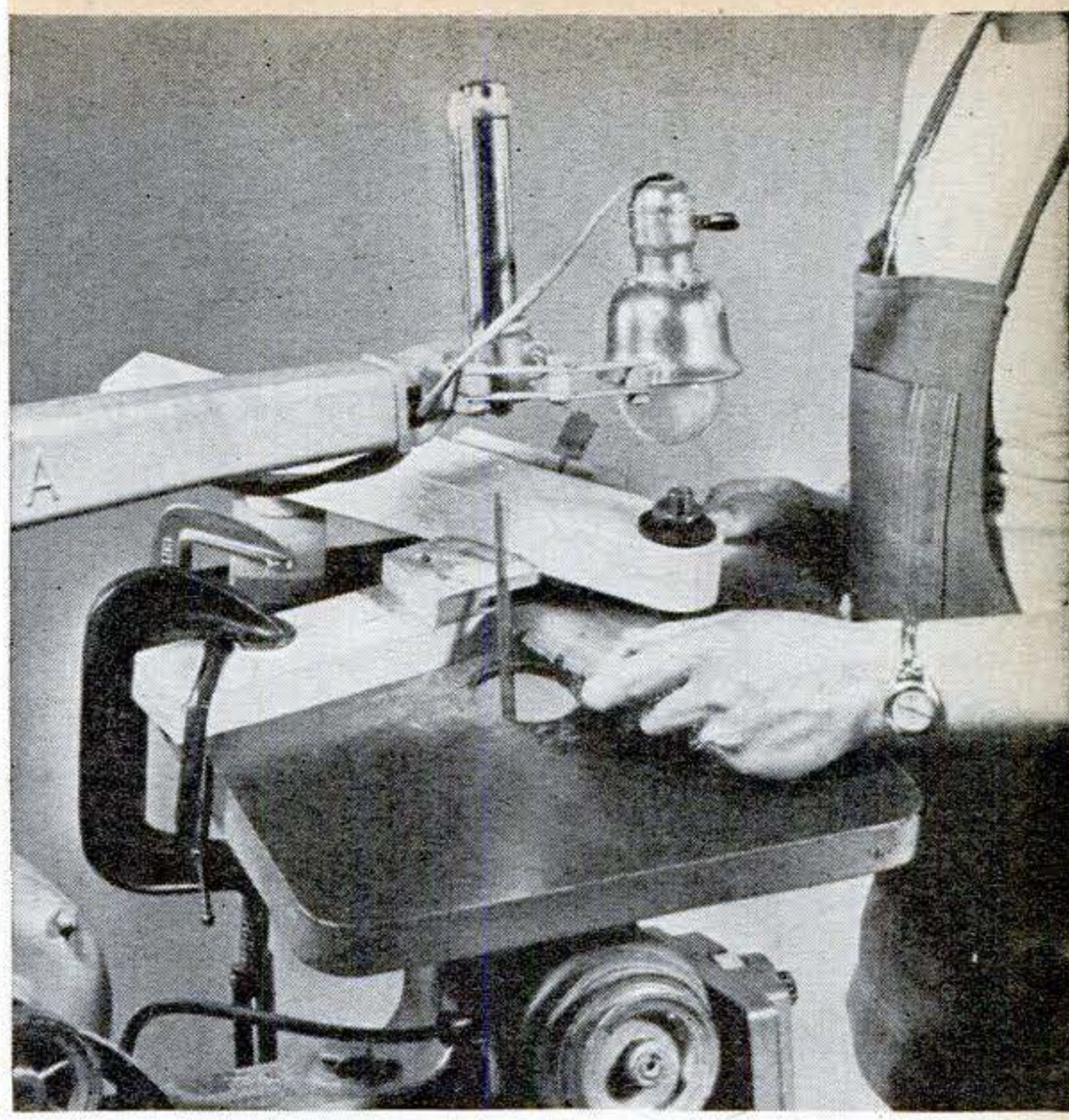


Tilt the table in one direction to bevel the backs of alternate teeth and in the other to finish the job. A caster behind the file will keep it from springing



Sharpen the faces of crosscut teeth on a planer blade with a three-cornered file, giving them a radial hook. The jigsaw table is tilted 18 deg.

up the jig and blade for filing the raker teeth at the backs in the same way as was done for filing the backs on the combination blade. But for a planer blade, the table is kept level. File all rakers in one setting, making them from 1/64″ to 1/32″ shorter than the crosscut teeth. If gumming the gullets is necessary, it is done in the same way as that described for combination saw blades. You will notice that the raker hook of most planer blades is usually slightly less than that of a combination blade.

To file the faces, replace the round-edge file with a three-cornered file having faces 5/16″ or more wide, and tilt the table 18 deg. File the faces of the crosscut teeth with a radial hook, tilting the table to the left for one set of alternate teeth and to the right for the other.

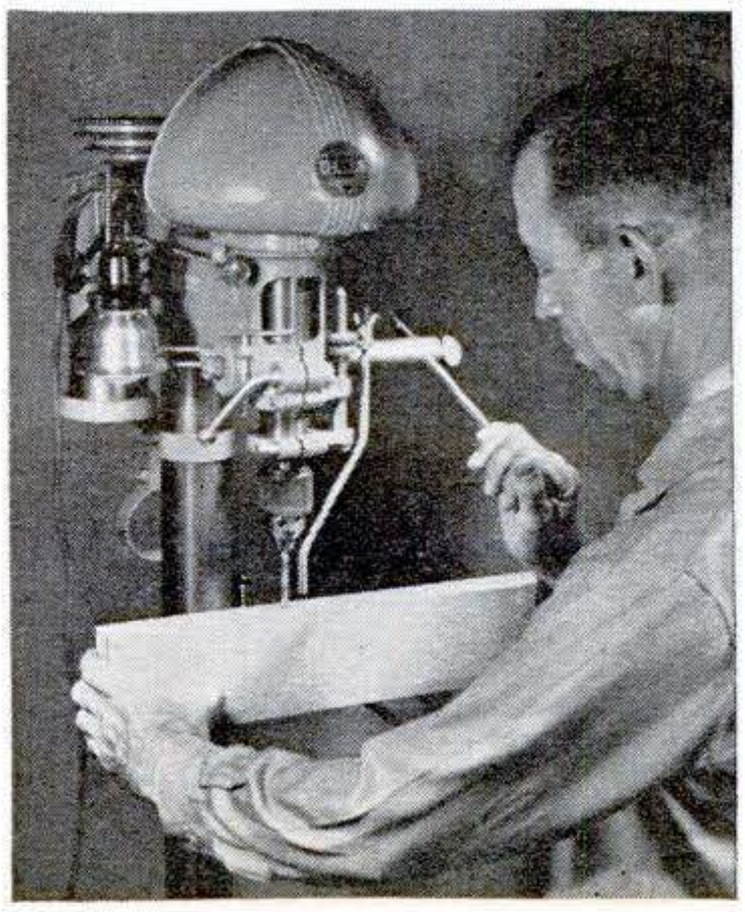
Does the grind make a difference? Whether the saw blade is hollow ground or flat makes no difference in filing the teeth. Where treatment does differ is in setting. Flat-ground blades require setting to provide clearance for the blade during cutting. But hollow-ground blades are usually designed so that the clearance is ample and no setting is ever required.

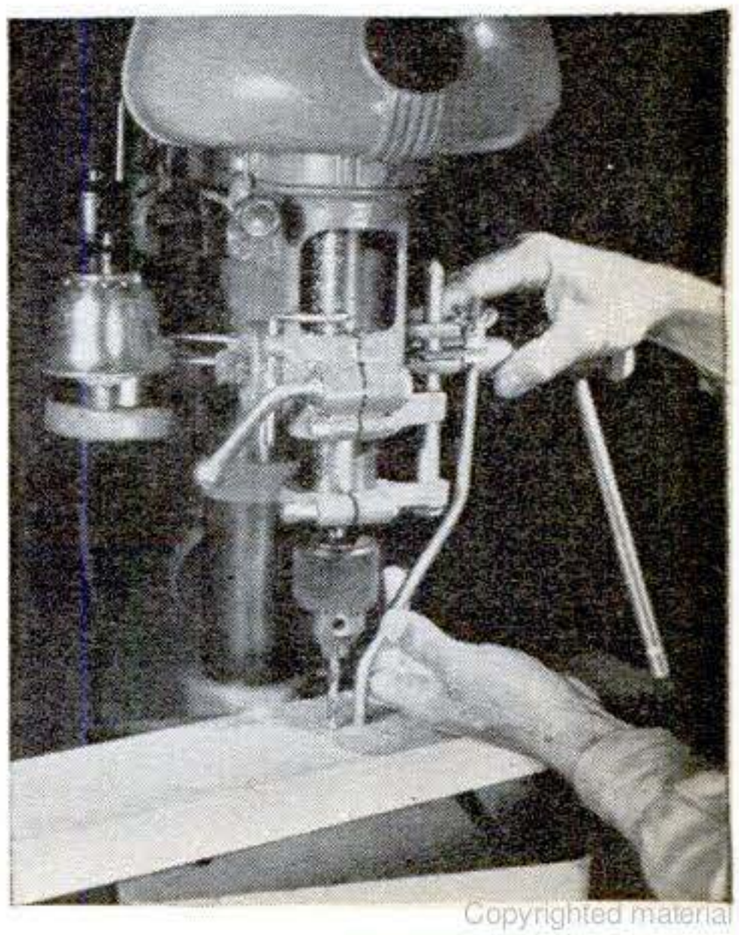
Stop Insures Drilling Uniform Depth in Work of Any Thickness

OCCASIONALLY holes must be drilled to the same depth in several pieces of stock that vary in thickness. The conventional drill-press depth stop is useless in this case because it gauges depth above the table and not from the work surface.

A suitable stop consists of a rod clamped between the nuts on the regular stop so that its end touches the work when the desired depth is reached. Thread a ¼″ or ⅜″ rod about 12″ long for 2″ from one end and bend it to the necessary offset. Make a flat bracket from a piece of metal about ⅛″ by 1″ by 2¼″, cutting a slot in one end so that it may be slipped on the threaded upright of the regular stop. Drill a hole near the other end for the stop rod and mount this with a nut and washer beneath and a wing nut with a second washer above the bracket. Make sure that the rod clears the chuck.

Adjust the bracket midway on the threaded portion except when it is necessary to use the full feed capacity of the press—F. H.





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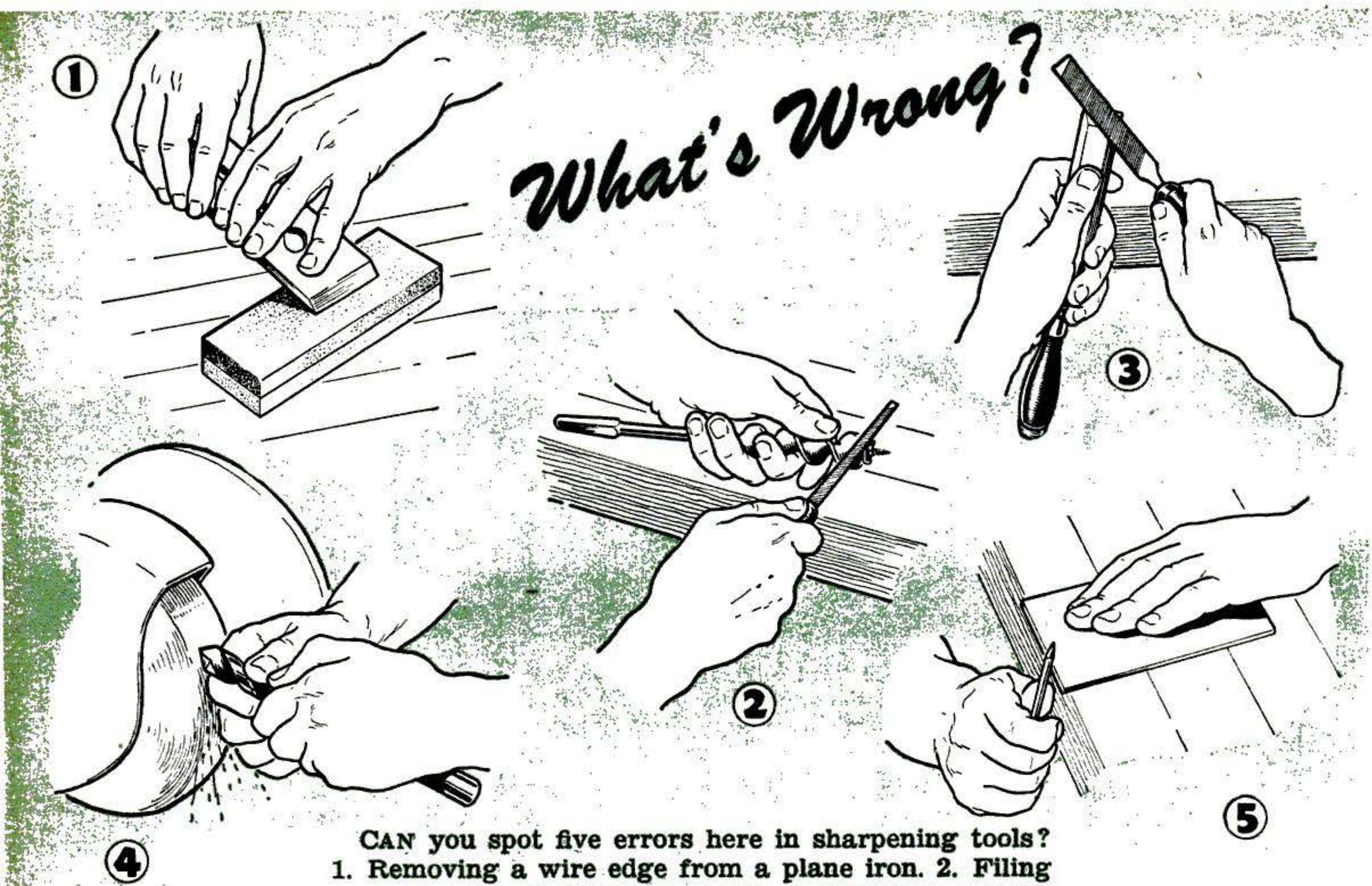
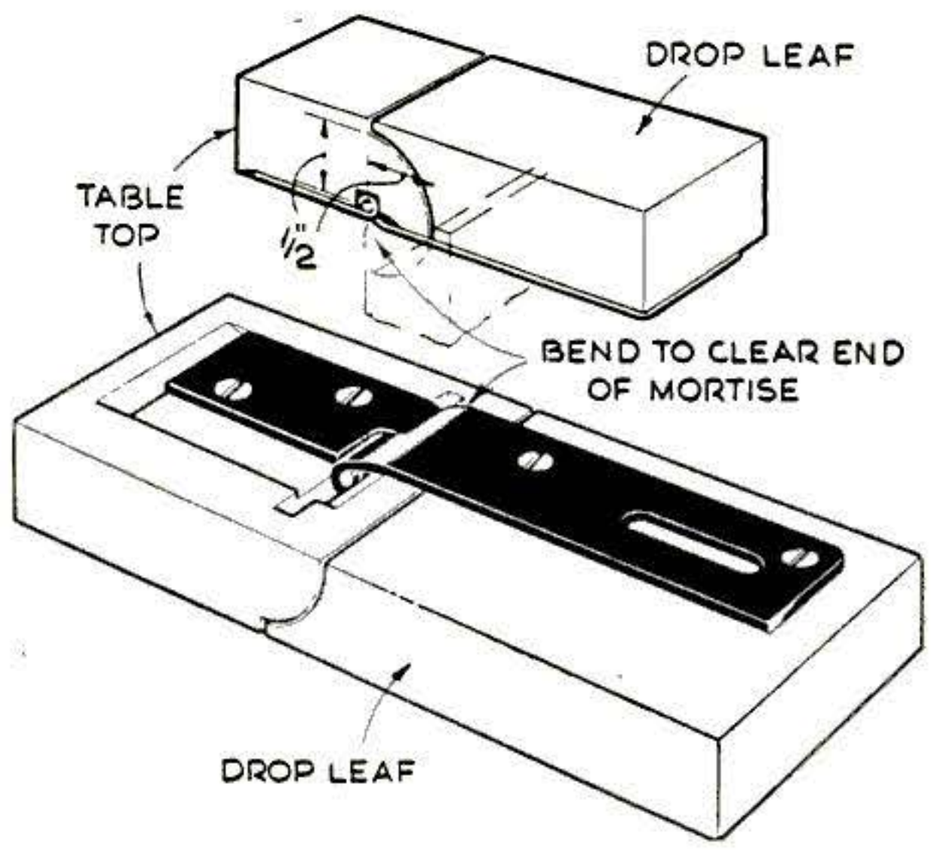


CAN you spot five errors here in sharpening tools? 1. Removing a wire edge from a plane iron. 2. Filing an augur bit. 3. Filing a chisel. 4. Grinding a twist drill. 5. Turning a scraper edge with a large nail.

ANSWERS: 1. Hold a plane iron flat on the stone when the bevel is up.
2. File augur-bit spurs on the inside so as not to reduce the diameter.
3. Good chisels are hard to file. Grind and whet them.
4. If ground as shown, a drill would receive a bevel on one cutting lip, which would prevent it from cutting. The proper way is to grind back of, and up to, the cutting lip. Freehand drill grinding is difficult at best.
5. Use only tempered and polished steel to turn the edge of a scraper. Such tools as a burnisher, a nail set, or the shank of a chisel will do the job.

HINGING A RULE JOINT [WOODWORKING]



Rule joints such as those used on drop-leaf tables require hinges having one flap longer than the other, and the hinges must be installed so the pins will be on the same center as the curve of the molding. Ordinary hinge hasps are ideal for the purpose. Drill screw holes in the long flaps and countersink them from the back.

Gauge lines on the underside of the table top ½" from the edge of the molding to locate the hinge-pin centers, and mortise slots for the hinge joints either by routing or chiseling. The usual radius of such moldings is ½" on a ¾" thick table top; if it should be greater or smaller, the gauged lines for the hinge-pin centers should, of course, be changed to correspond.

Now, by routing, or with a circular saw using a dado head or a molding head equipped with flat knives, make a stopped mortise to receive the short flap of the hinge. The depth of the mortise must be such as to center the hinge pin ½" from the top of the quarter-round portion of the molding. Stop the mortise as shown, and bend the long flap of the hinge in a vise to clear the closed end of the mortise; then screw the long flap to the table leaf without mortising. Insert heavy paper in the joint when assembling in order to gauge clearance; otherwise rubbing will wear the finish.

If preferred, the hinge mortises in the table top can be extended to the edge, and the long flaps then mortised into the drop leaves without bending. The ends of such top mortises will show, however, if the lowered table leaf is swung out of plumb.

POPULAR SCIENCE MONTHLY SHOP DATA

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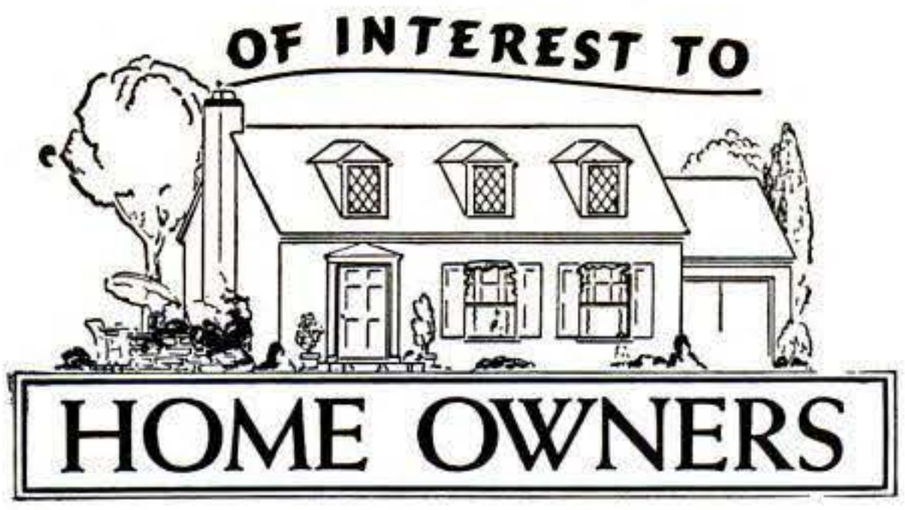
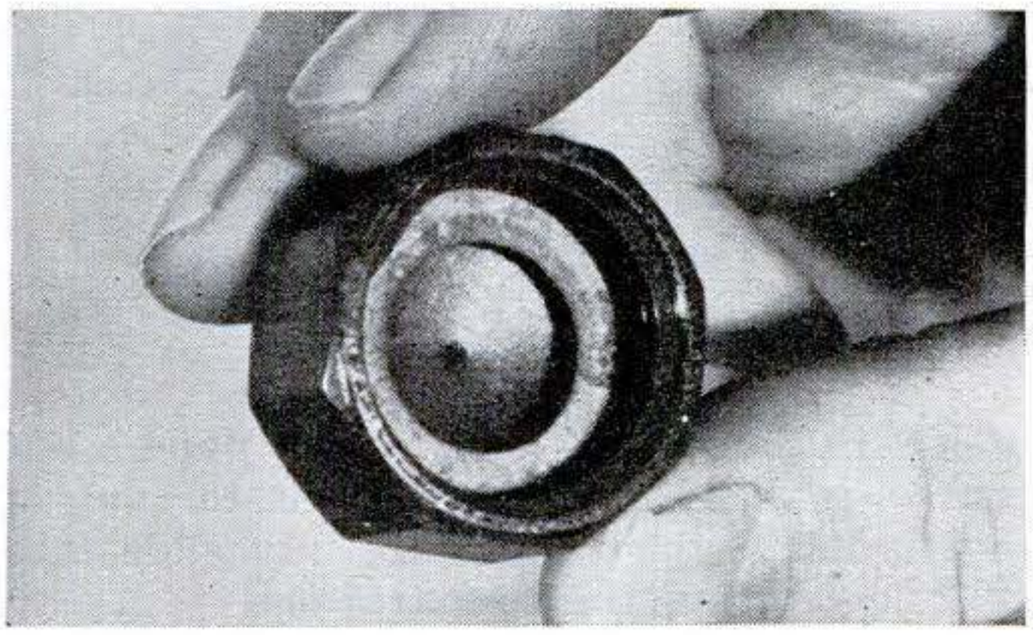


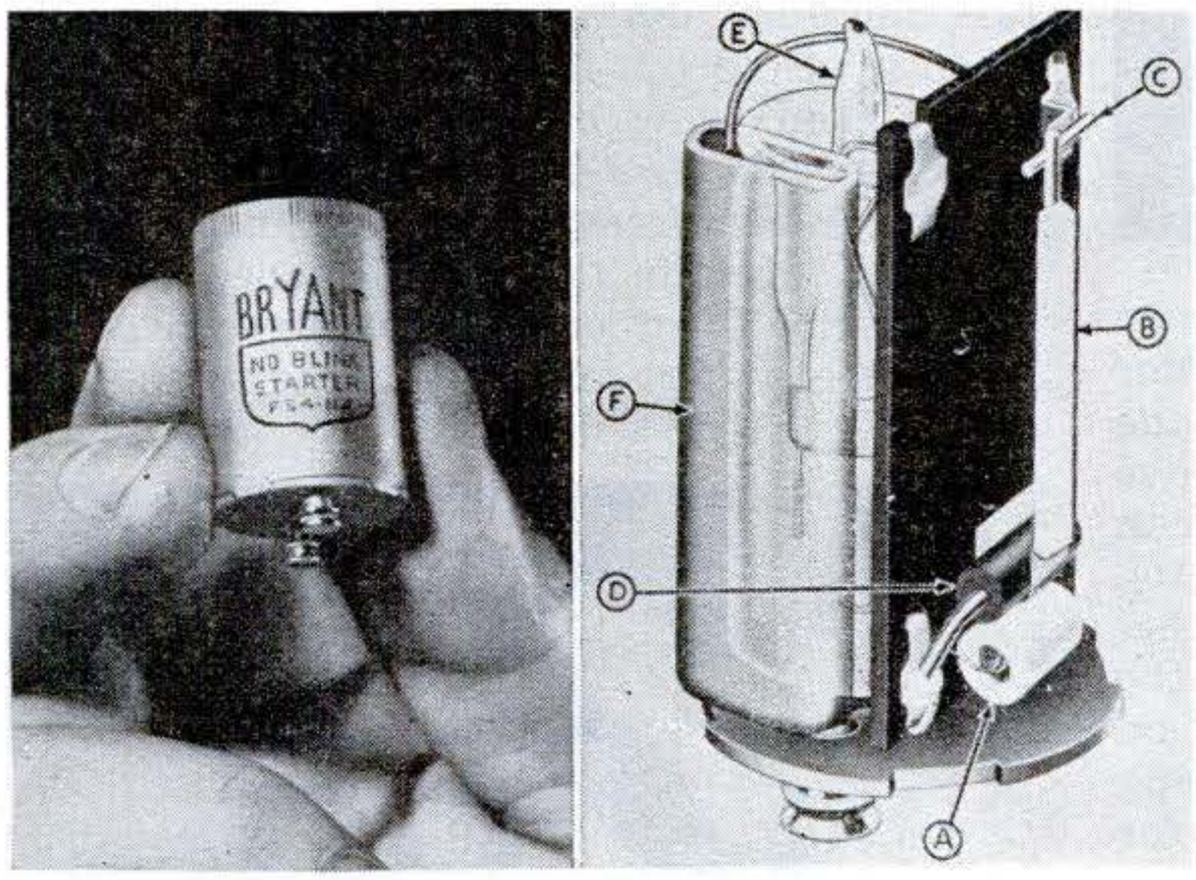
WALLPAPER REMOVAL is speeded when the old paper is thoroughly soaked by a new sprayer that is attached to the garden hose in place of the regular nozzle. The sprayer is held about 15″ from the wall and moved slowly to allow the mist to soak in. It is made by the Mistic Manfacturing Company, of Cincinnati, Ohio.



THESE NEW DUSTPANS are molded of brightly colored cellulose acetate plastic with a pliable front rim that shapes itself automatically to the contour of an irregular floor. They are rustproof and won't chip or crack, and the color is nonfading, according to the manufacturers, Plastic Molded Products, Inc., of Los Angeles.

FLICKERING of old fluorescent tubes is stopped by an automatic switch that has been incorporated in a new type of starter. This eliminates the blinking that is common in tubes that have become deactivated and are at the end of their useful life. The automatic switch built into the no-blink starter mechanism shuts off the current, just as the filament breaks in an old incandescent lamp, and the light ceases abruptly instead of flickering annoyingly.

New elements in the starter are the resistors and a bimetal switch shown at *A*, *B*, *C* and *D* in the cutaway drawing and the wiring diagram reproduced here through the courtesy of the *Westinghouse Engineer*. When the lamp is functioning normally, current flows through the starter mechanism only long enough for the original units *E* and *F* to strike the arc through the mercury vapor. But should the lamp fail to light, the current flowing repeatedly through the resistance *B* heats bimetal switch *C*, opening the circuit. A minute current through resistor *D* keeps *C* open until a new tube is installed.



Resistors and a bimetal switch in this fluorescent-lamp starter will shut off current when the tube fails to start readily

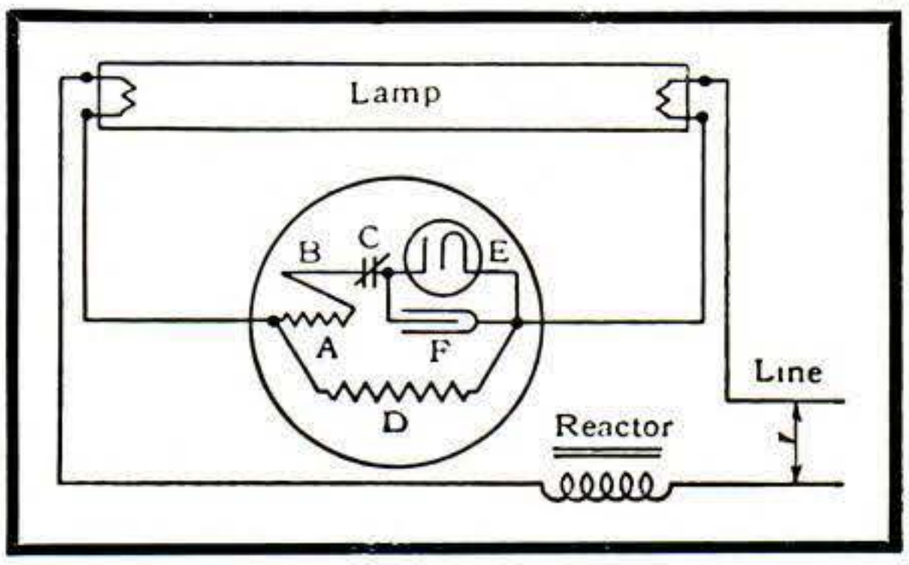


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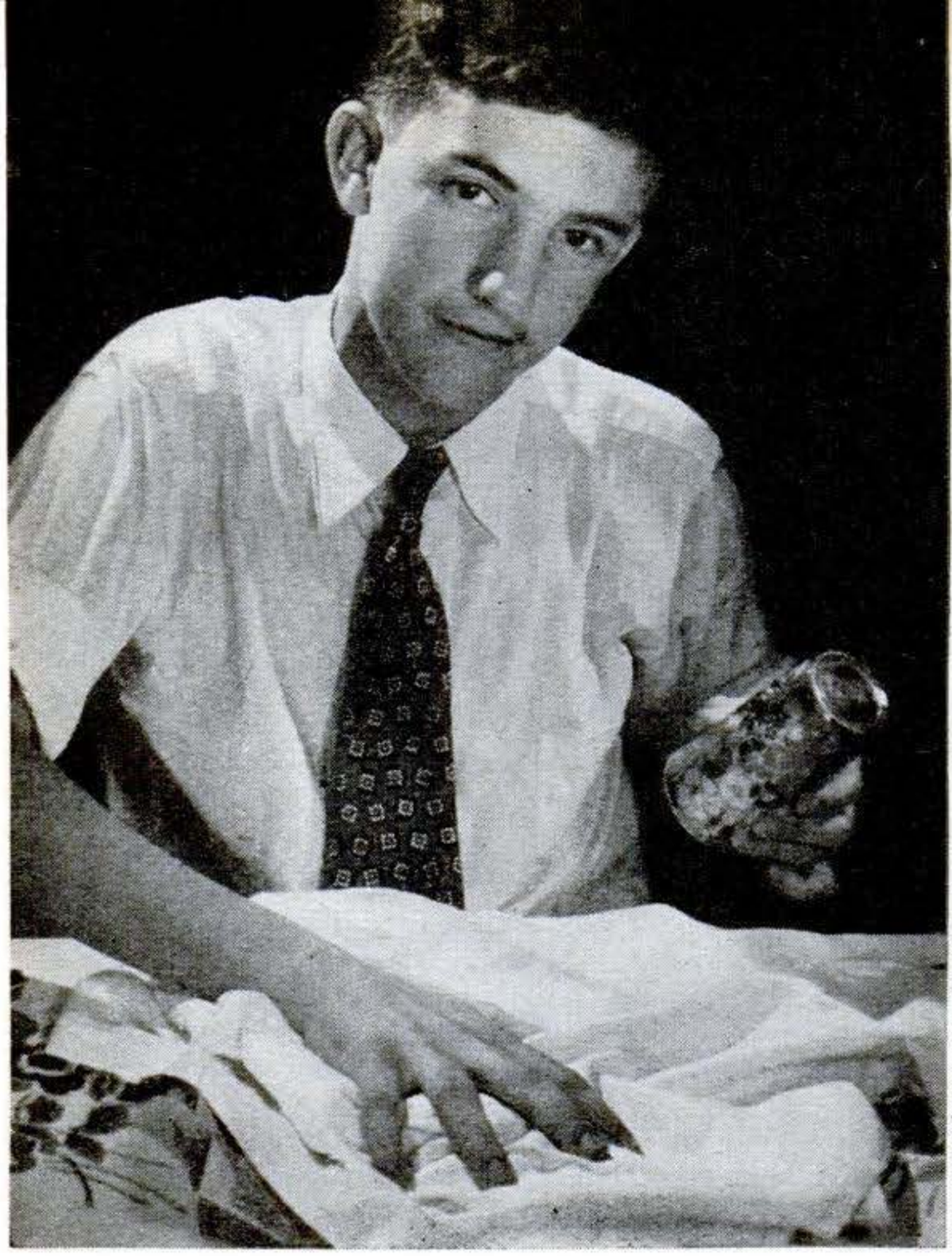
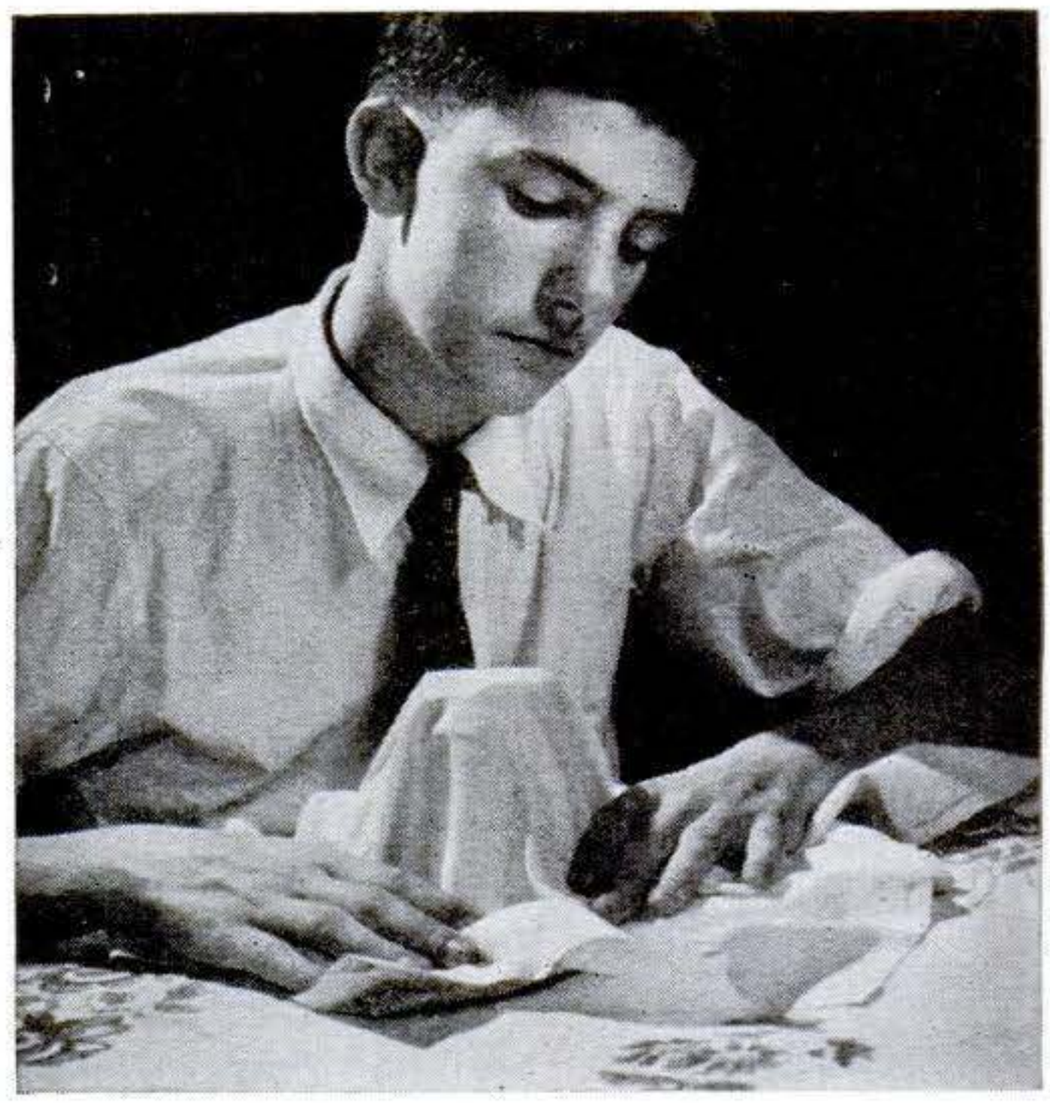
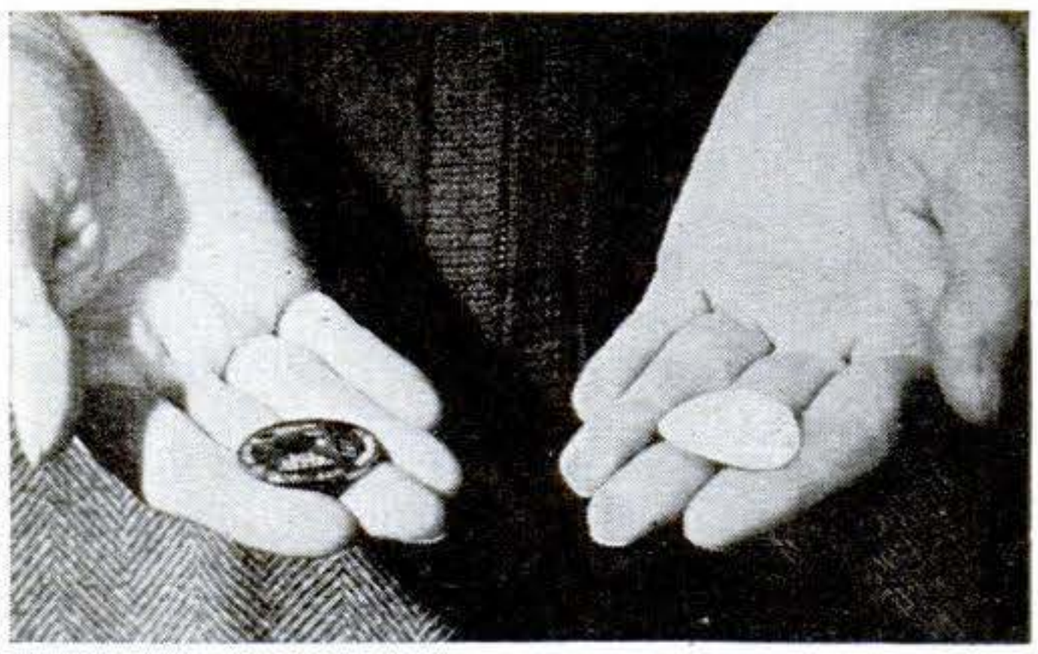
TABLE TRICKS





PUSHING A TUMBLER through a table and bringing it out from the underside is easy—if you know how. Place it mouth down on the table and press over it firmly several sheets of newspaper. Then lay a napkin over the mound, telling your friends it is to catch the pieces in case of mishap, and flatten the paper with a smart blow. Magically you produce the glass from your lap under the table! The pressed papers, of course, make a form that seems to contain the tumbler which you carefully slide into your lap during the preparations.

One way to add interest is to pretend to fail several times in an attempt to make a coin disappear from under the tumbler. Then fake anger and strike the mound sharply to do the glass trick instead.



CHALLENGE your friends to drop a coin and a paper disk of the same size or smaller from equal heights and have them reach the floor at the same time. After they have tried unsuccessfully, show them that it can be done by smoothing the paper disk on top of the coin, which is held horizontally before lease. Lowered air pressure above the coin during its fall will hold the paper on securely. Any other method of releasing them will cause the disk to flutter down far behind the coin.

THREE CHECKERS touching in a row can be made to perform their own special trick. Ask your guests to try to put one of the end checkers between the one in the middle and the one at the other end—but to make it hard, specify that the middle checker must not be moved and the checker at the far end must not be touched! Here's how to do it. Hold the middle check against the table; then draw one of the end checkers back and hit the middle checker with it solidly. A compression and expansion wave passing through the middle checker will bounce the third one far enough away to leave plenty of room between the two.

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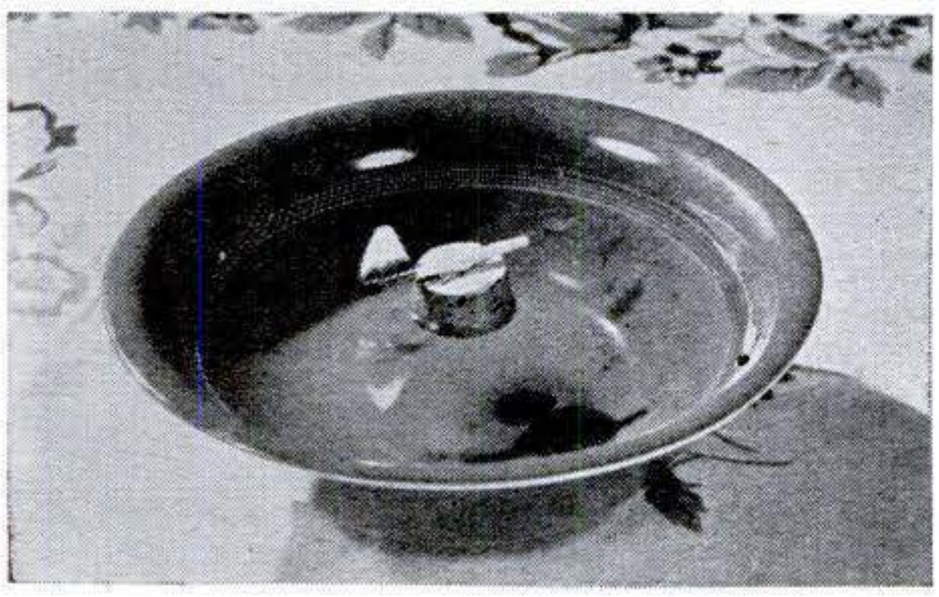
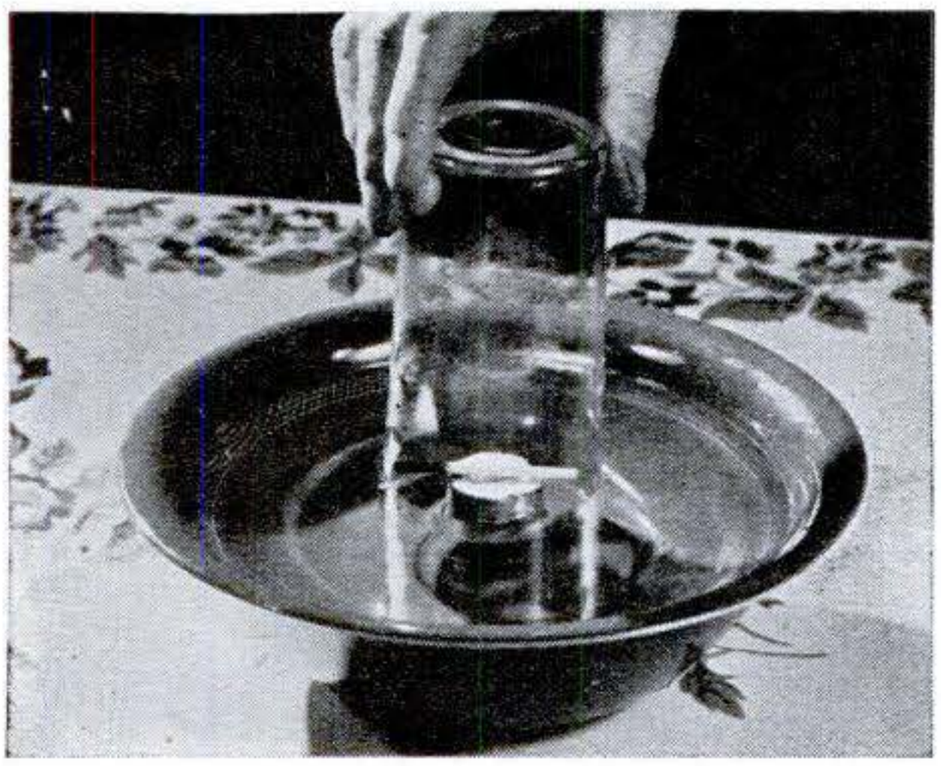
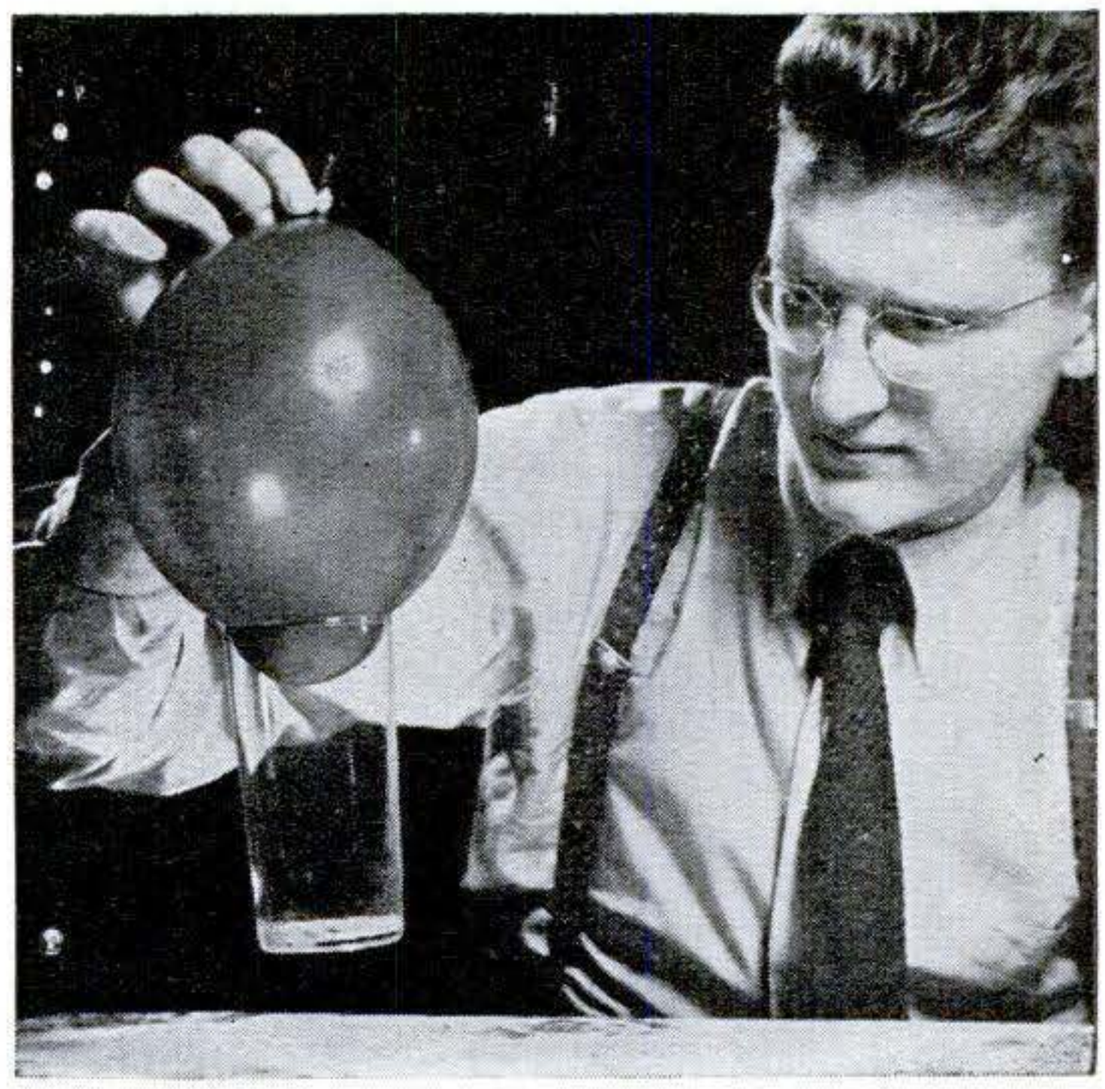
LOWERING A MATCH below the surface of water and having it remain lighted is really just a gag. Place the lighted match across a flat cork floating in water in a deep dish, and place the mouth of a large tumbler over it, lowering it to the bottom. Air pressure in the tumbler will depress the water, and the match will drop below the surface of the remaining water in the dish! For an extra flourish, raise the tumbler quickly enough and the match will stay lighted.

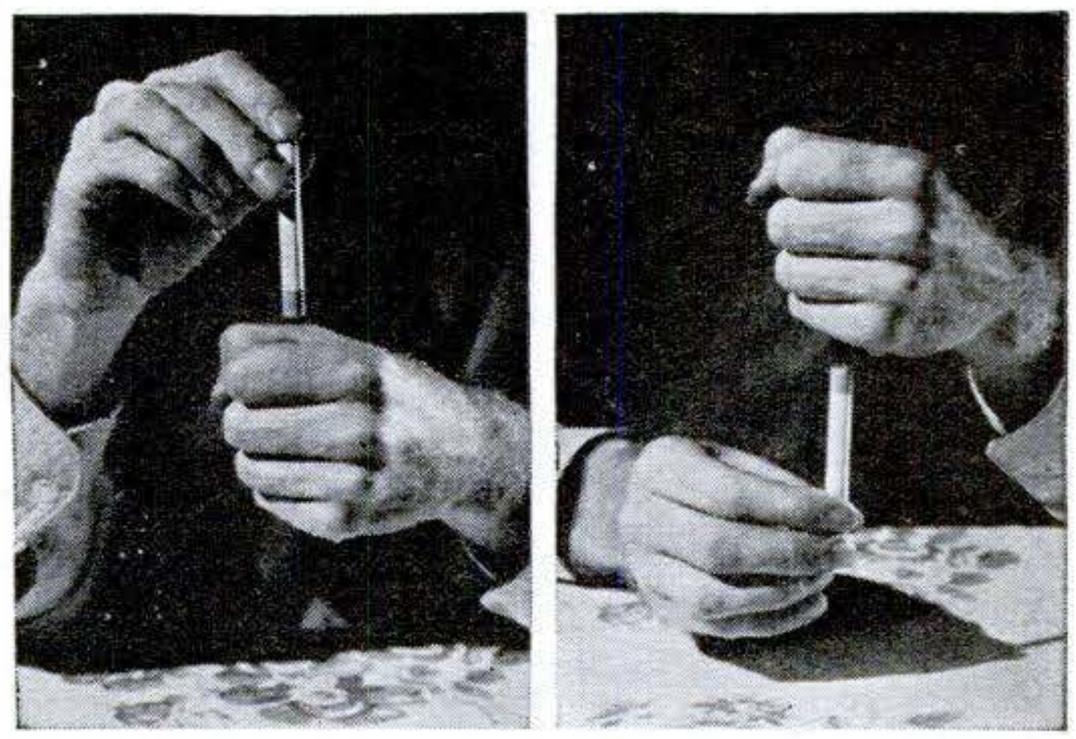






USE OF A BALLOON to lift a tumbler seems impossible only if you aren't in on the secret. Drop a lighted paper match into the bottom of the glass and, while it is still burning, place the balloon in contact with the rim. Amazingly, that part of the balloon within the rim will begin to bulge and, when the match has gone out, it will provide a firm grip for lifting the glass! What happens is that a partial vacuum is created by the consumption of oxygen in the glass.

THOUGHT PROJECTION is often done professionally on the stage. You can demonstrate it at home; but you are apt to get varying kinds of reaction from your friends. Write a word on a slate or a sheet of paper and keep it concealed. Select one listener and say that you are concentrating on the word. Tell him that you want him to be perfectly frank—that if you fail, it will not be the first time. Then ask: "Can you tell me the world I have written?" Of course, he will answer, "No." And now you will astonish him by exclaiming: "That is absolutely right!" What you have written on the slate is the word "No"!



REVERSING THE CORKED END of a cigarette is one of those tricks that must be performed quickly and the "prop" put away. Cut the cork-tip end from a cigarette, remove the paper carefully from inside the tip, and open the cord strip where it overlaps. Now, wrap this cord band around a plain cigarette, gluing the ends together so it is just tight enough to slide along the cigarette. As shown in the photos, you put the cigarette, cork tip down, in one clenched hand, push it through, and pull it out from the bottom. The cork will have slid to the top!

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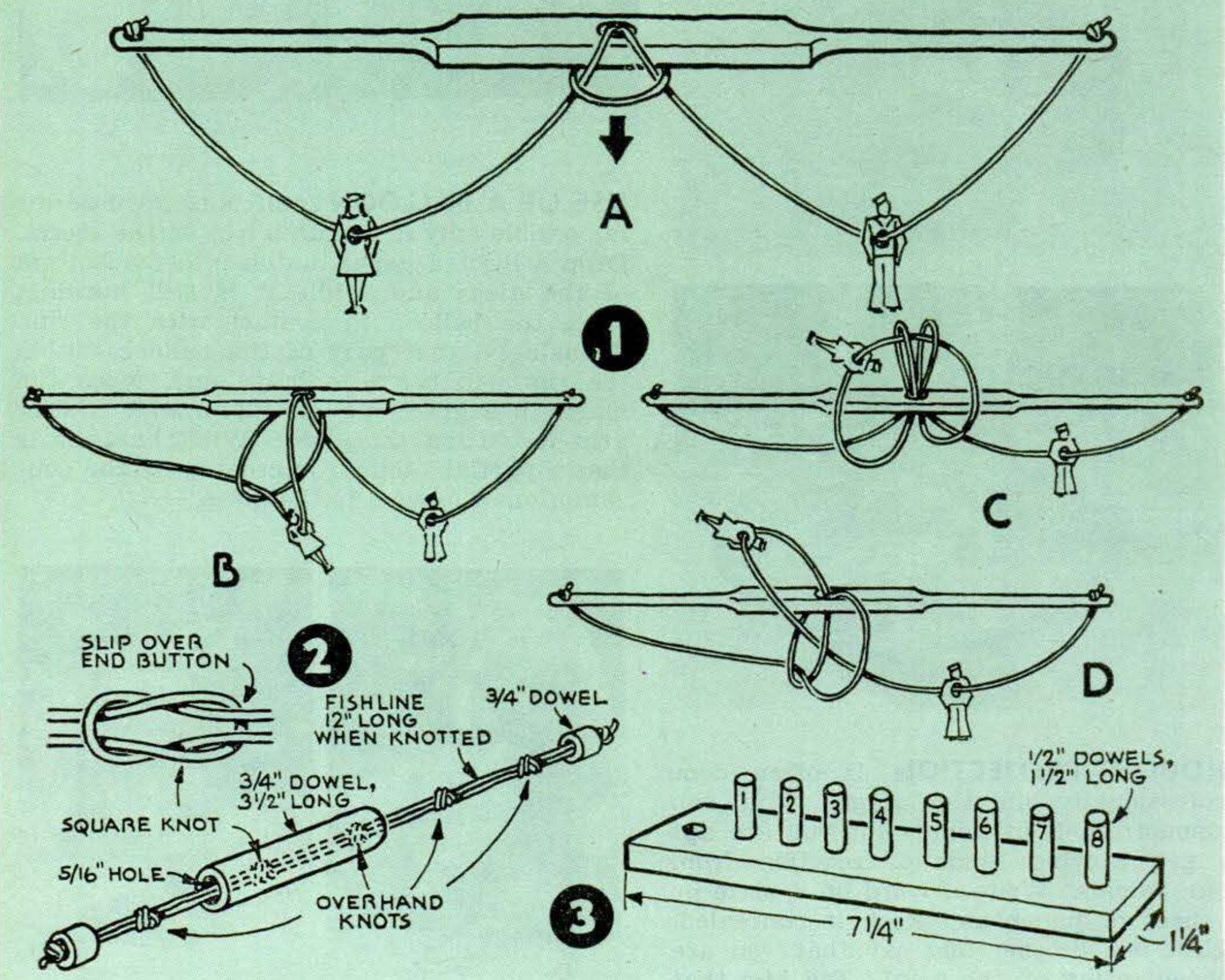
1 HOW CAN BOY meet girl when they are in the fix illustrated below? It's easy if she's a sailor's girl and will cross the spar to him. Pull loop *A* down and slide the girl through it, as at *B*. Draw the loop up through the hole in the spar by pulling on the two center cords.

This puts the girl in position to be slid through the two loops, as at *C*. Now, if you will draw the double loop back down through the hole, as at *D*, the girl can be slid through to reach her sailor! Then arrange the loop as it was in the first position.—R. M. COWAN.



2 KNOTS IN A FISHING LINE will fool your friends when they try this trick. The problem is to get the long dowel off the knotted line without removing the short end dowels. You can do it if, in preparing the trick, you make one knot a square knot, while the others are overhand knots. Slip one of the square-knot loops over an end dowel, and the knot will pull apart. Instead of drilling dowels, you can substitute package-carrier handles.—GEORGE BARR.

3 CAN YOU REVERSE the order of the pegs in the board so that No. 8 will be at the opposite end and the sequence will read the other way? Move either by jumps or single moves. You can make it into a game, with the winner the player with the smallest number of moves. Here's one solution, in 36 moves. Shift the pegs in this order *four* times, always jumping to an empty hole: 2, 4, 6, 8, 7, 5, 3, and 1; and then move 2, 4, 6, and finally 8.—G. B.

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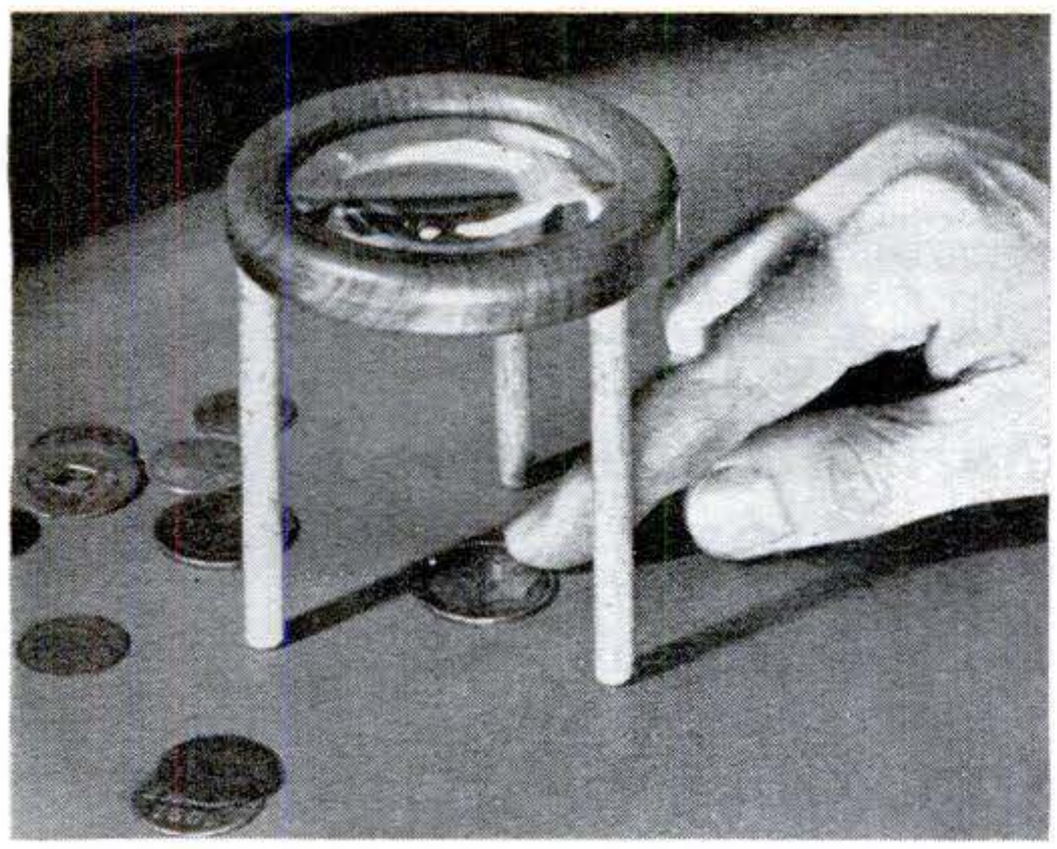
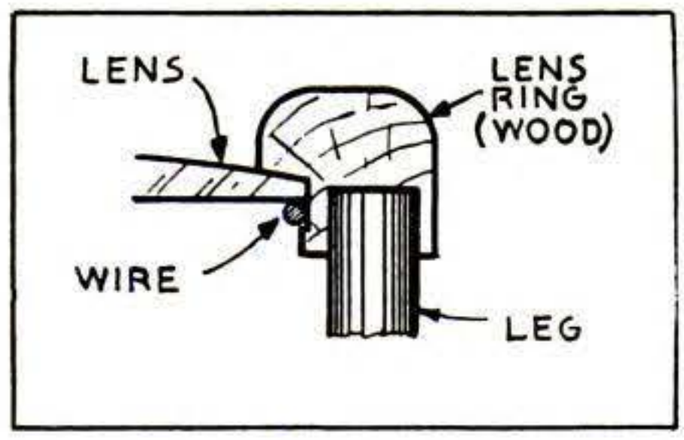
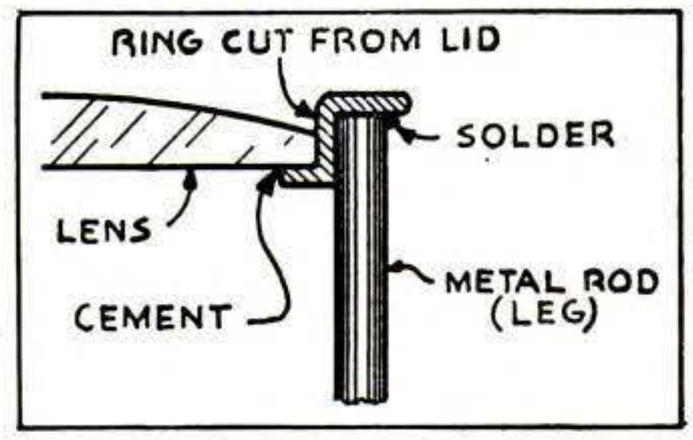




Simple Tripod Stand Supports Magnifying Lens at the Correct Distance Above Work



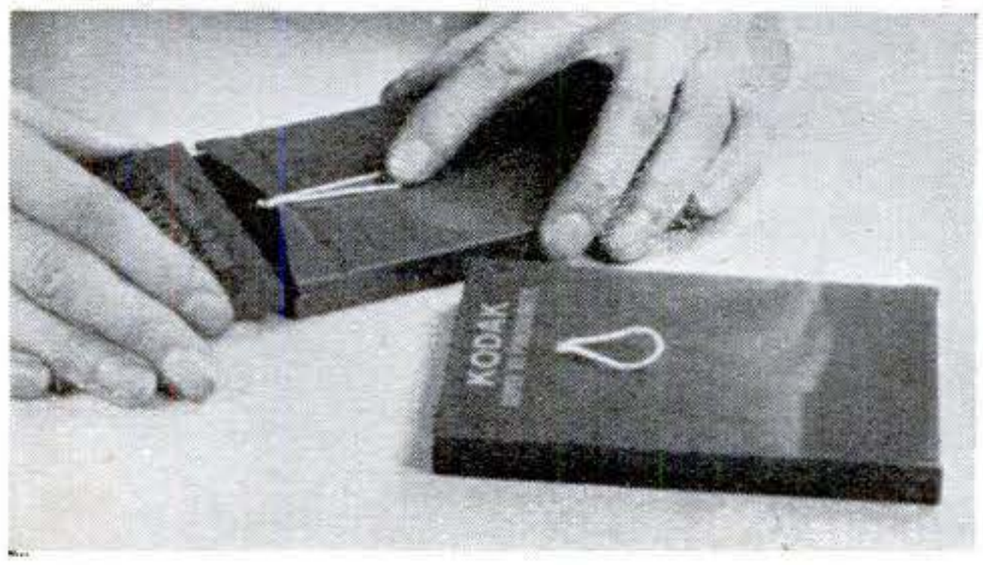
ONE of the handiest little optical devices for the home, shop, office, and laboratory is a tripod magnifier. It consists of a positive lens in a mount supported by three legs of such length that the lens focuses sharply on the surface upon which they rest. It is particularly useful for examining stamps, coins, fine drawings, pressed botanical specimens, and the like. One caution should govern its use: it should never be left where the sun might strike it and start a fire by a burning-glass effect.

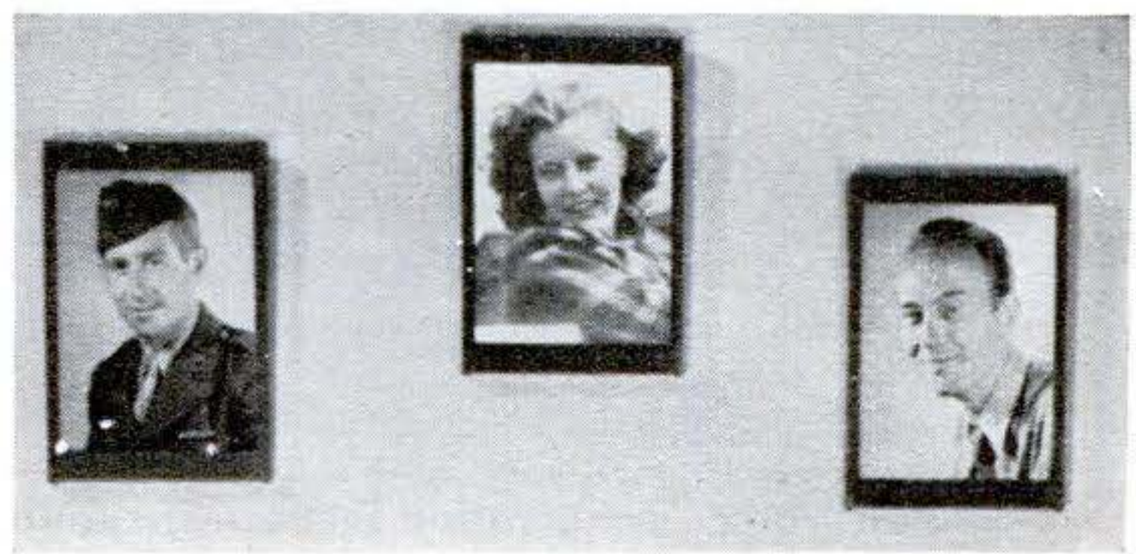
Shown in the photos is a tripod stand turned from red cedar. The blank was fastened to a faceplate with the intended upper surface outward, the ring roughed out, and the lens recess formed by undercutting with an offset tool. A small boring bar could have been used. Calipers were used to determine when the recess would receive the lens, after which the ring was finished and cut off. For the three legs 3¼" lengths of ¼" dowel were used, set into holes ¼" deep and spaced 120 deg. apart. These holes may be bored at a slight angle to flare the legs outward a bit, though with low stands the legs may be set vertically. A split ring holds the lens. A different method of construction, shown in the drawing at the right, is to use a ring cut from the press-on lid of a small tin can.

Experiment to determine how far from a surface the lens gives the sharpest image with the eye at a comfortable height. In general, a lens with a focal length between 1¼" and 4" is best.—ERVIN WALTERS.

Empty Film-Pack Containers Serve as Attractive Picture Frames

NEAT, simple frames for your contact prints may be devised from the containers in which film packs are supplied. Cut a cardboard backing piece to keep the print pressed against the aperture in the side of the container. Use a small, knotted loop of string for hanging vertical photos, securing it by placing the knot in the V-shaped cut at the back of the container and then replacing the top.—WILLIAM SWALLOW.





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His Photos Make the Bunny's Nose Twitch

WILL CONNELL, CAMERA CRAFTSMAN, TELLS HOW HE BRINGS THE FEELING OF LIFE TO PICTURES OF ORDINARY SUBJECTS

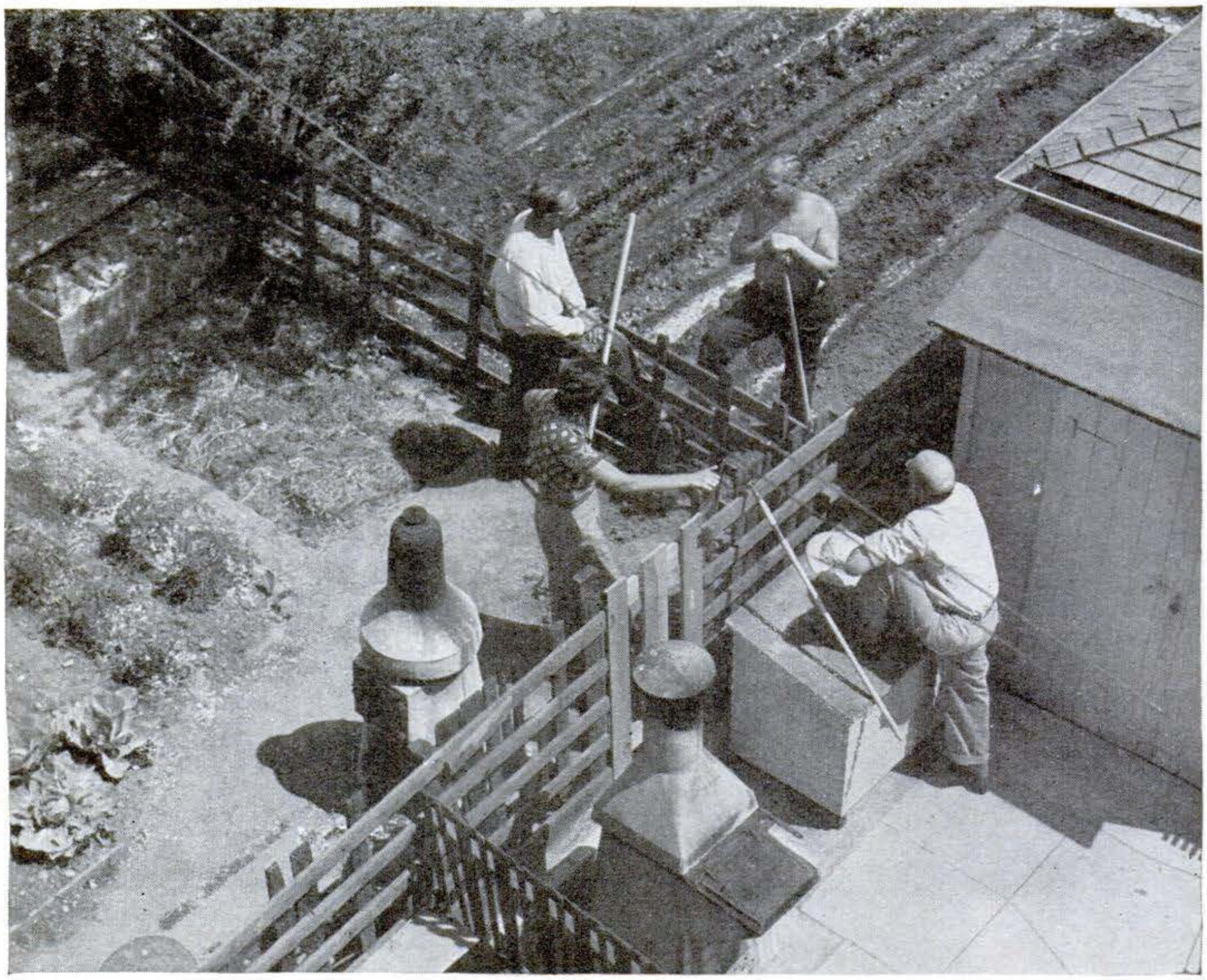
By Andrew R. Boone

ONE of photographer Will Connell's favorite expressions is, "Wait for the bunny's nose to twitch." Its meaning is simple—don't touch the shutter release until the scene before your camera tells the story that you want to catch. This valuable advice comes from a man famous for the scope, power, and infinite variety of his pictures.

Connell, who numbers among his clients national advertising agencies, top-notch magazines, and huge industrial plants, started out as a registered pharmacist. A decade of pill rolling in a series of Los Angeles drug stores so bored him that he still considers the life of a photographer to be a fairyland existence.

There's more than a bit of the pixie in this creator of serious pictures. He much prefers a laugh-provoking novelty picture to a dramatic study of a 100-octane gasoline tower. This feeling for humor is due, he says, to a brief experience he had as a cartoonist on the Los Angeles Examiner.

From compounding drugs and drawing cartoons, curiosity led him into the photo-supply business. During this phase of his career, he found himself teaching the rudi-



Backyard Conversation Piece—Casual and Intimate, Yet Structurally Sound

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Study in Contrasts—Rough-Textured Adult Hands Accentuate Baby's Delicacy

ments of photography to his customers. Eighteen years ago, in 1927, he decided that he could succeed as well as the men who were profiting from his advice; so he hung out his shingle, announcing his availability to all and sundry as a commercial photographer.

Today, roaming widely throughout the western part of the country, he functions as a critical interpreter of the American people and their environment. Catholic in his photographic tastes, he prefers not to be considered a specialist. His assignments come from a variety of sources—on one day he may busy himself filling a hurry-up order for a full-color magazine cover, on another day he may stalk dramatic effects in an industrial plant for a national advertiser, and on still a different day he may spend his time shooting book illustrations for his author-wife.

Hal Stebbins, a well-known advertising man, pays this tribute to Connell: "When you look at a picture by Will Connell, you *forget* it's a picture. . . . He *keeps* the life that looks into his lens."

Connell considers that his success and consequent reputation have been built upon twin foundations. First, he works with a lavish hand, making innumerable negatives and everlastingly seeking to tell a story rather than merely to snap a photo. Second, he manipulates his negatives in the darkroom as an etcher works with his plates, striving patiently to produce the exact print values desired. Sometimes his work has the sure audacity of a steam locomotive, while at other times it displays the precise delicacy of a fine watch. He may make 10 or 12 prints before he finally achieves on paper the interpretation he seeks.

He hopes always to remain an unbiased, eager, experimentative, and unorthodox student of the graphic arts. For instance, although he is not too fond of miniature cameras, he often uses a Contax just to prove to himself that he has an open mind. He went out recently with two Speed Graphics, a Graflex, and the Contax, all hooked to one synchronizer, to take full-color pictures of a cowboy riding a bucking bronco. Three times in the yellowing afternoon light he flashed the scene. He found later, to his amazement, that the hand-held Contax had captured the best picture—on 35-mm. Kodachrome at 1/1,000-second.

Some first-flight photographers consider that elaborate props are essential. Not Connell, though—he uses his living room as a studio, and if conditions require it, will not hesitate to process his negatives in a bathroom. Only occasionally does he employ professional models. Usually he's to be found hunched behind his camera "on

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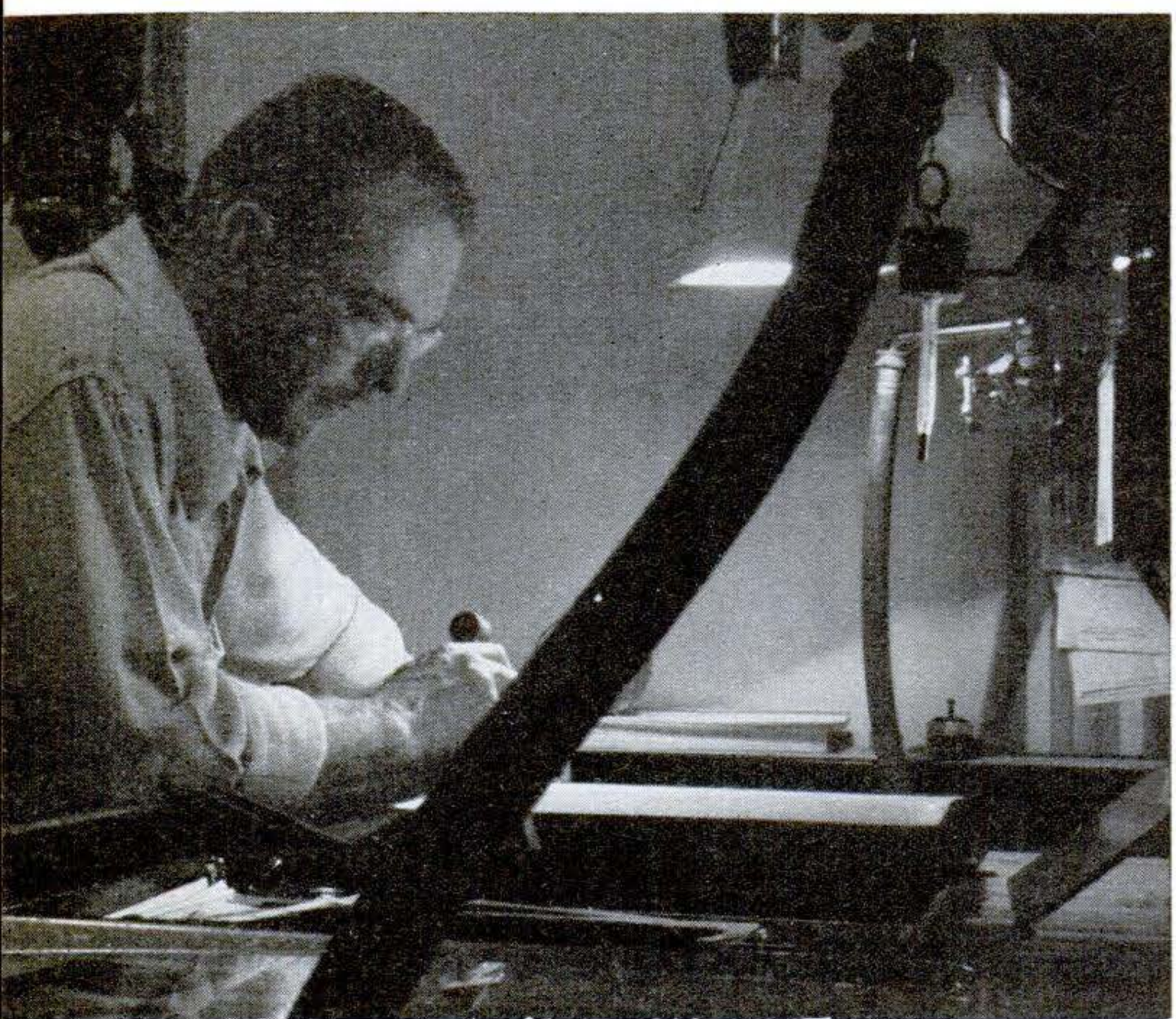
location." Before every setup, he makes pencil sketches, which, he admits, are "undecipherable by anyone else."

Most of his work is done with a 4" by 5" Korona and a 3½" Schneider-Angulon lens, set on a studio tripod. He has extensively altered the camera to suit his requirements. Seldom does he shoot faster than 1/50 second, although the Korona is capable of 1/200-second shutter speed. A synchronizer gives him a flash source at the camera. If the occasion demands, it can be augmented with batteries of flash bulbs.

Why a tripod? "I guess there's something of the plumber and the amateur in me," Connell confesses. "With my camera on a mount, I can deliberately take time to think through to the desired effect before taking a picture."

Though he considers a view camera such as his Korona to be the basis for any serious work, he employs a Speed Graphic when there's action to be shot, particularly if he wishes to take several shots in rapid succession, or if he must work in a crowded room.



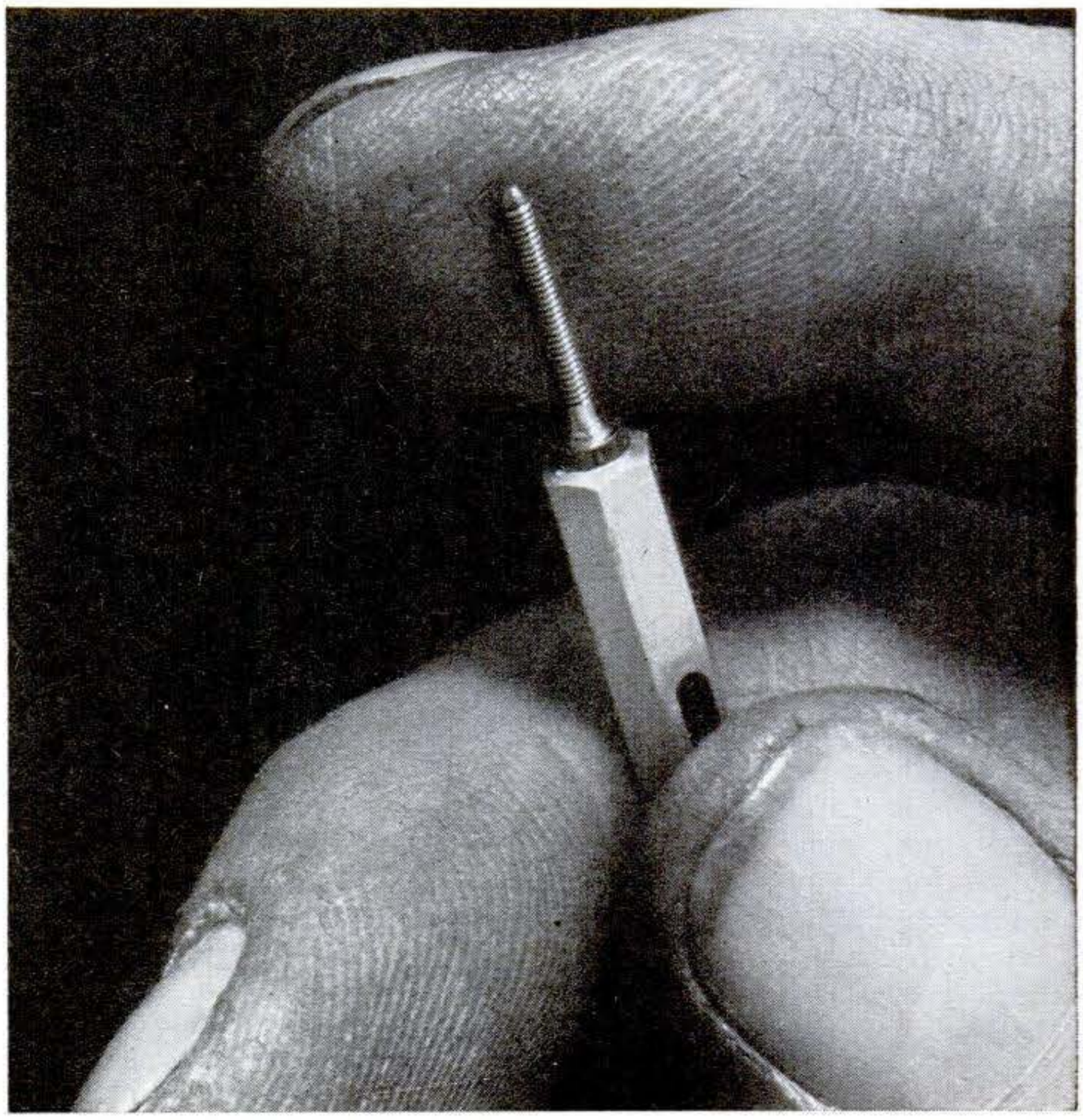
Will Connell, Camera Craftsman

Besides these two cameras, he has six others in current use. Although most of his color work is done on 4" by 5" Kodachrome, he occasionally sets up a one-shot color camera that he developed when color was in its infancy. He also uses a 5" by 7" Ansco, a 4" by 5" reflex, and a Contax with an f/1.5 lens.

As an inflexible rule, he practices with a new camera in the dark until he can focus, shoot, change plates, and shoot again without watching what he is doing. He drills regularly with both the Korona and the Speed Graphic. Notches cut alongside the focusing scale—on the Korona at 6′ and infinity and on the Graphic at more frequent intervals — enable him to make accurate adjustments simply by his sense of touch. As a matter of routine, he unlimbers his equipment, sets up the Korona on the tripod, focuses, and makes a single-flash picture in 90 seconds. "Any craftsman," he emphasizes, "should be able to do his job without wasting time fiddling with his tools."

Of the eight lenses in his

Industrial Subject—A Thread Gauge



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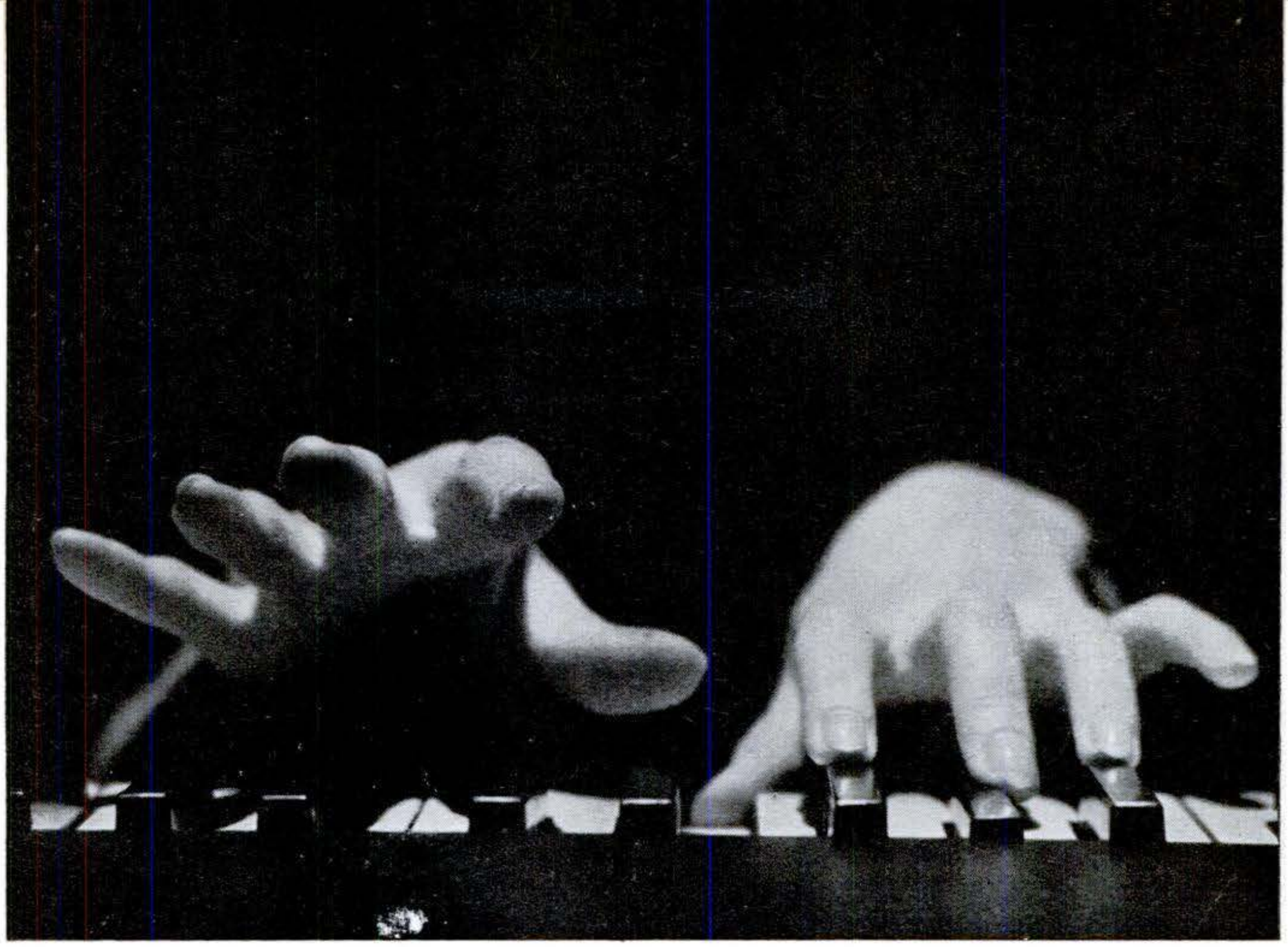

Legato—A Dramatic and Powerful Study

carrying case, his favorite, circumstances permitting, is an 8¼" Steinheil Cassar, f/3.5. For portraits he uses a 10½" Cassar, which he claims brings out the roundness of heads in a superior manner. "I prefer to use the longest lens that will maintain the angle of view, because it gives the most acceptable perspective," he says. "Remember, the eye is equivalent to about a 9½" lens on a 4" by 5" field. Shorter lenses tend to rub your nose in the subject."

He sticks pretty close to high-speed films of one standard brand, because through long familiarity he knows the results he will obtain. To speed his work on a job, Connell has standardized on 4" by 5" plate holders for all his cameras except the Contax. This makes for economy and does away with the necessity of carrying a variety of film on an assignment that requires the use of more than one type of camera. He prefers 4" by 5" negative to larger or smaller ones because he finds that people tend to freeze in front of a large camera, while images on a small film are too minute for quick study. He considers 2¼" by 2¼" to be the smallest practicable size. If he should ever lose his present cameras, he probably would adopt 3¼" by 4¼" as his new standard size.

On assignment in an industrial plant, he spends hours roaming through the buildings, climbing over scaffolding, crawling around piping, and making his unintelligible sketches to develop the pattern and mood before he shoots. Painstakingly he experiments with the placing of lighting, attempting to make it flow over and envelop the subject. Angles of attack are plotted to give a normal, receding plane of values. The foreground is planned to provide contrast of a sort that sets up an interesting pattern, serves as an interrupting form, and, most important, emphasizes the horizontal depth of the scene.

The picture on page 176, showing the four-way intersection between Connell's and his neighbors' back yards, is a preliminary black-and-white study of a scene that he later photographed in color for a magazine cover. (The color shot was never used because the magazine editor didn't like the incinerators in the foreground.) Of the picture, Connell says, "There's a nice, intimate, homey feeling here. The design and pattern make the picture structurally sound. It's quite unstudied in appearance, too, but I worked like the deuce for that effect of casualness." Concerning the next picture—the one showing the baby on his father's lap—Connell remarks, "The contrast between the homely, honest, rough hands and the delicate baby suggests strength and security."

A study of Connell at work in a darkroom appears on page 178. He prefers to do his own developing and printing, feeling that they are just as important in achieving the desired result as is the original conception and shooting of the subject material.

Trifles sometimes become tremendous

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Midday Interlude—Typical Americans In a Natural, Unstudied Pose

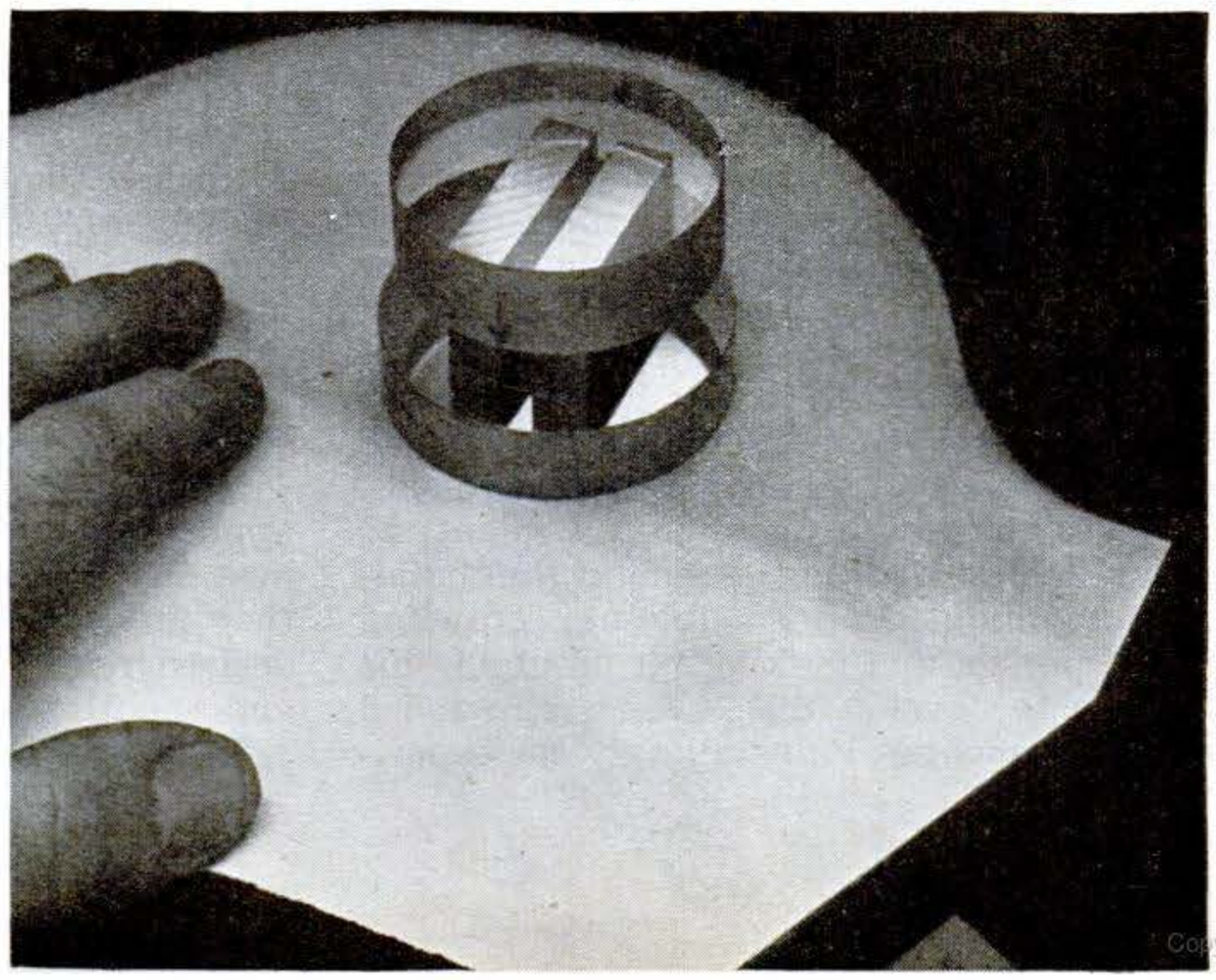
when recorded by Connell's camera, as witness the 1/16" thread gauge on the same page. The rough, white-paint-smudged texture of the fingers emphasizes the smallness, precision, and delicacy of the tool. The shot was made with his triple-extension view camera, racked full out. A 5" Turner-Reich convertible lens was used, giving him a total stop of about f/256. Five Wabash No. 0 flash bulbs illuminated the scene at an exposure of 1/25 second.

In the next picture—of a musician's hands—you aren't conscious of the photographer's presence. You *feel* that the hands are playing, dramatically and with power. Connell removed the keyboard from the piano to avoid using a mirror, which would have limited the camera angle.

On this page, the arresting study of workmen at lunch is so natural, casual, and unstudied that you feel as though you were with these men, not merely looking at a photograph. Connell used full daytime exposure and a single flash bulb at the camera—a hand-held Speed Graphic. The picture was taken on Super Panchro Press type B film at a speed of 1/10 second and a diaphragm aperture of f/16. The flash picked up the foreground and faces, while the background remained normally lighted.

The close-up at the bottom of the page was shot with an overhead ultraviolet light. A spot was used to pick up the hand and the incidental shadows. The photo shows two optically flat glass disks and two Johannson blocks. Newton's rings appear where the blocks touch the upper disk. The picture is purely scientific, but to liven it up Connell used a hand and an irregularly shaped piece of paper for contrast. It shows good design and is an effective presentation of the manufacturer's precision product.

Pictorial Science—Testing Gauges for Accuracy



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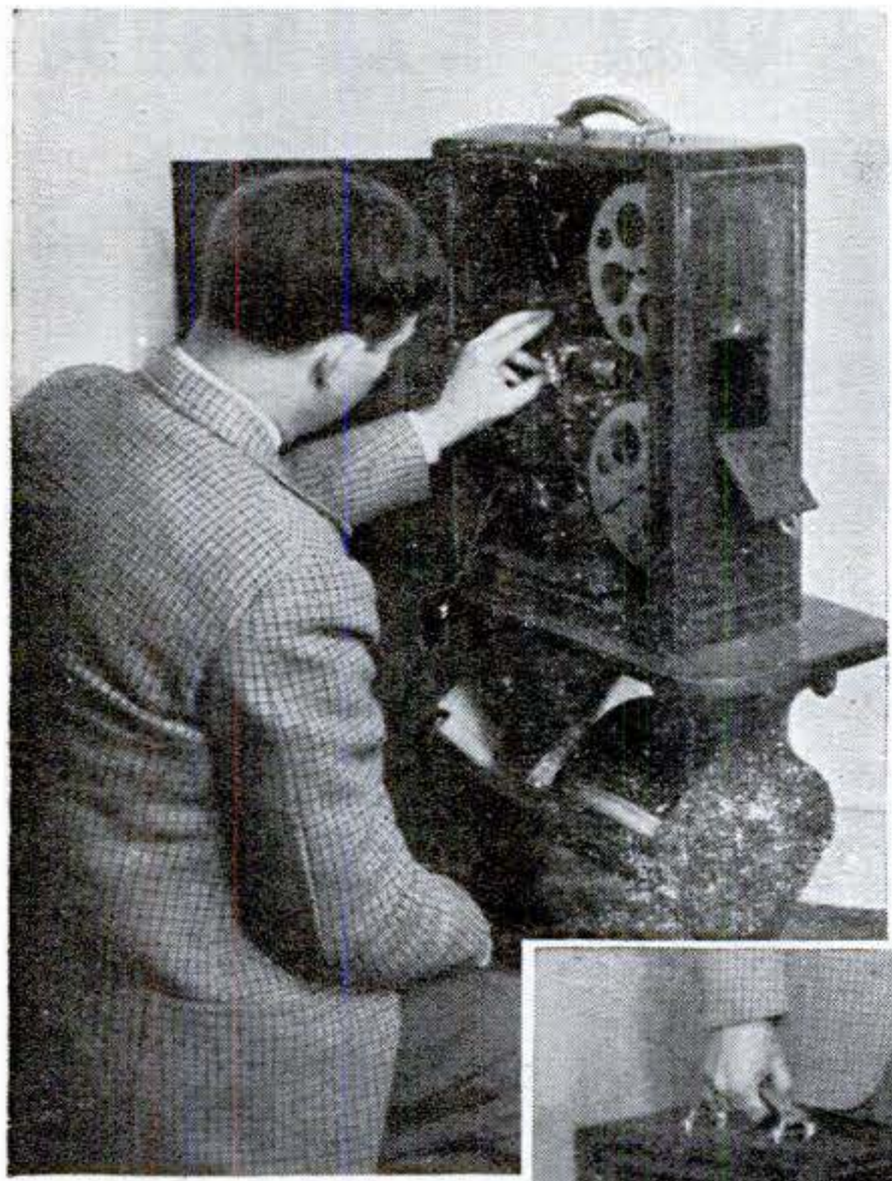
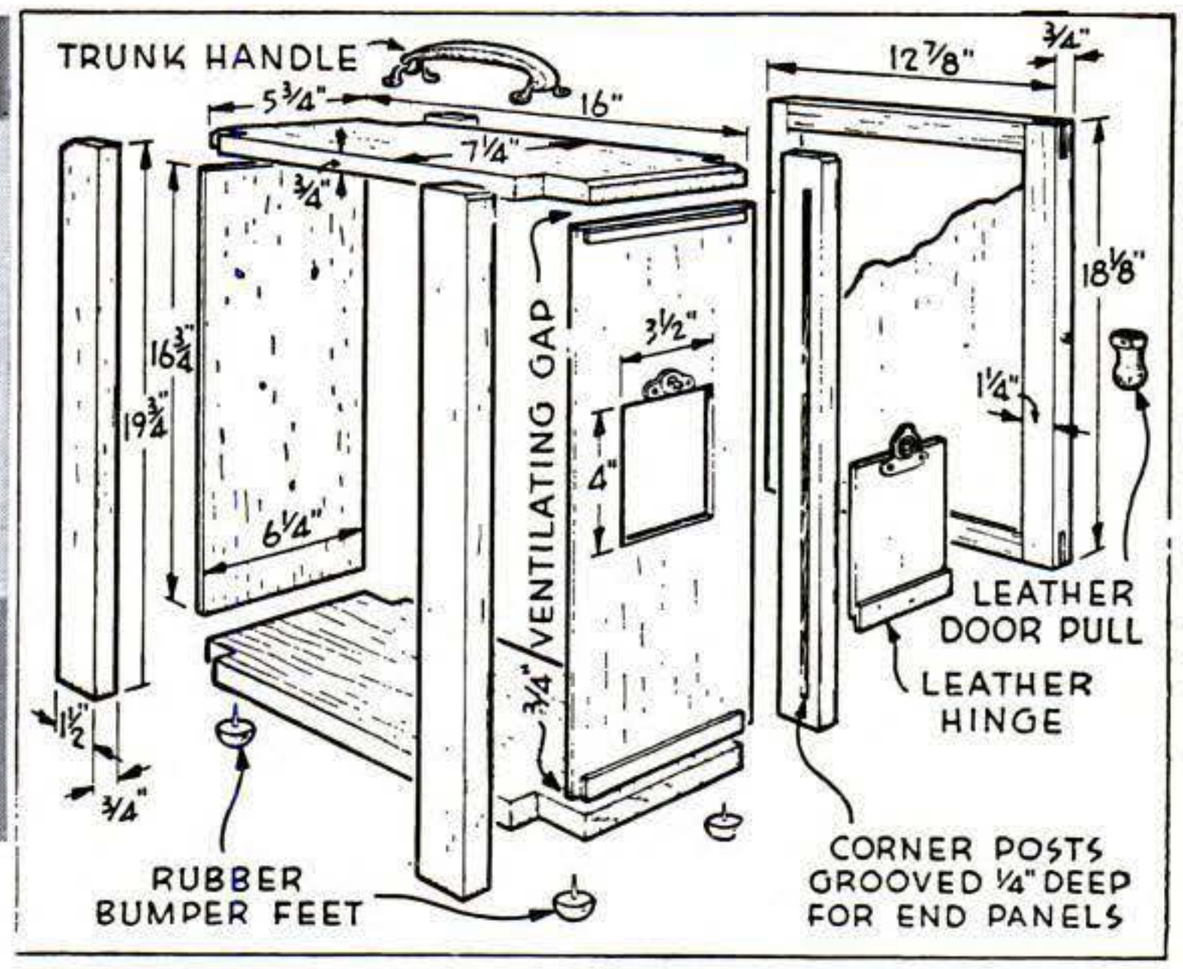


YOUR HOME PROJECTOR can be set on a table in this case and operated without being taken out, for the case serves as a permanent housing as well as for carrying and for storing. Ventilation sufficient for an hour's showing is provided by ¾" gaps above and below both the front and back panels; while full ventilation for longer operation may be had by swinging the two doors wide.

Use plywood for the end panels and side doors and solid pine for the posts, top, bottom, and door frames. If the aperture in front of the lens is cut carefully, the cutout piece can be used for the small door there. In assembling, glue the end panels to the posts first, and then glue and screw the posts to the top and bottom. Friction catches will serve on the doors. Mount the projector with screws.—A. H. SMITH.

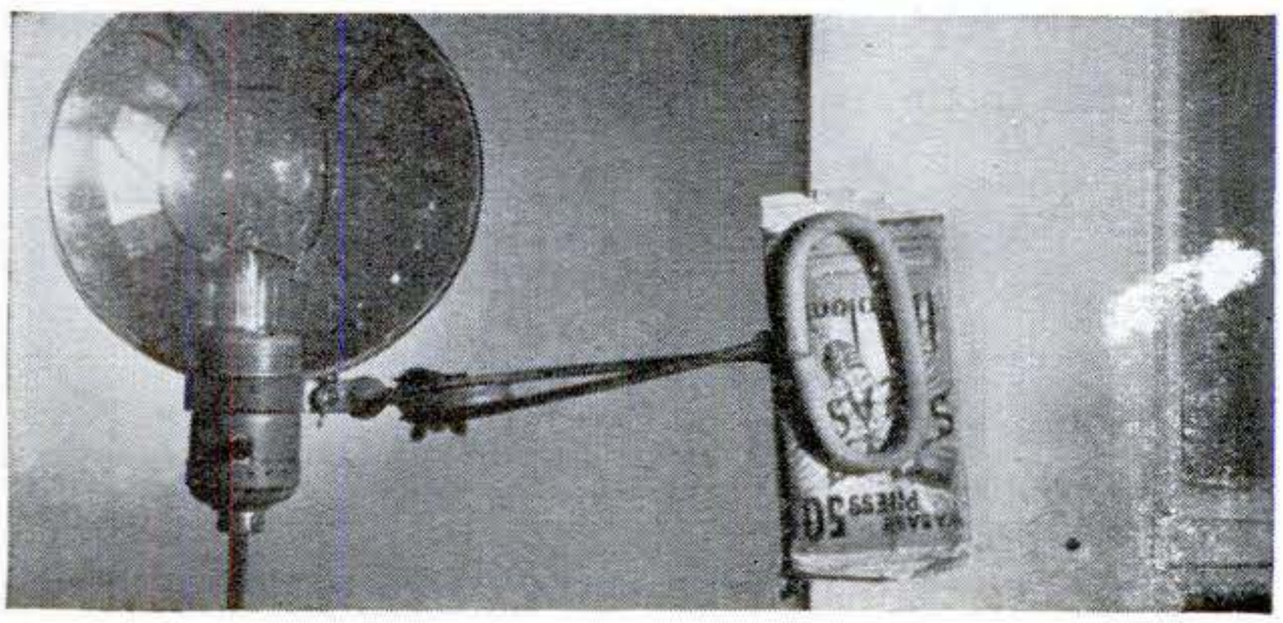
Doors forming the sides of this case provide ample room for changing of a reel, belt, or lamp

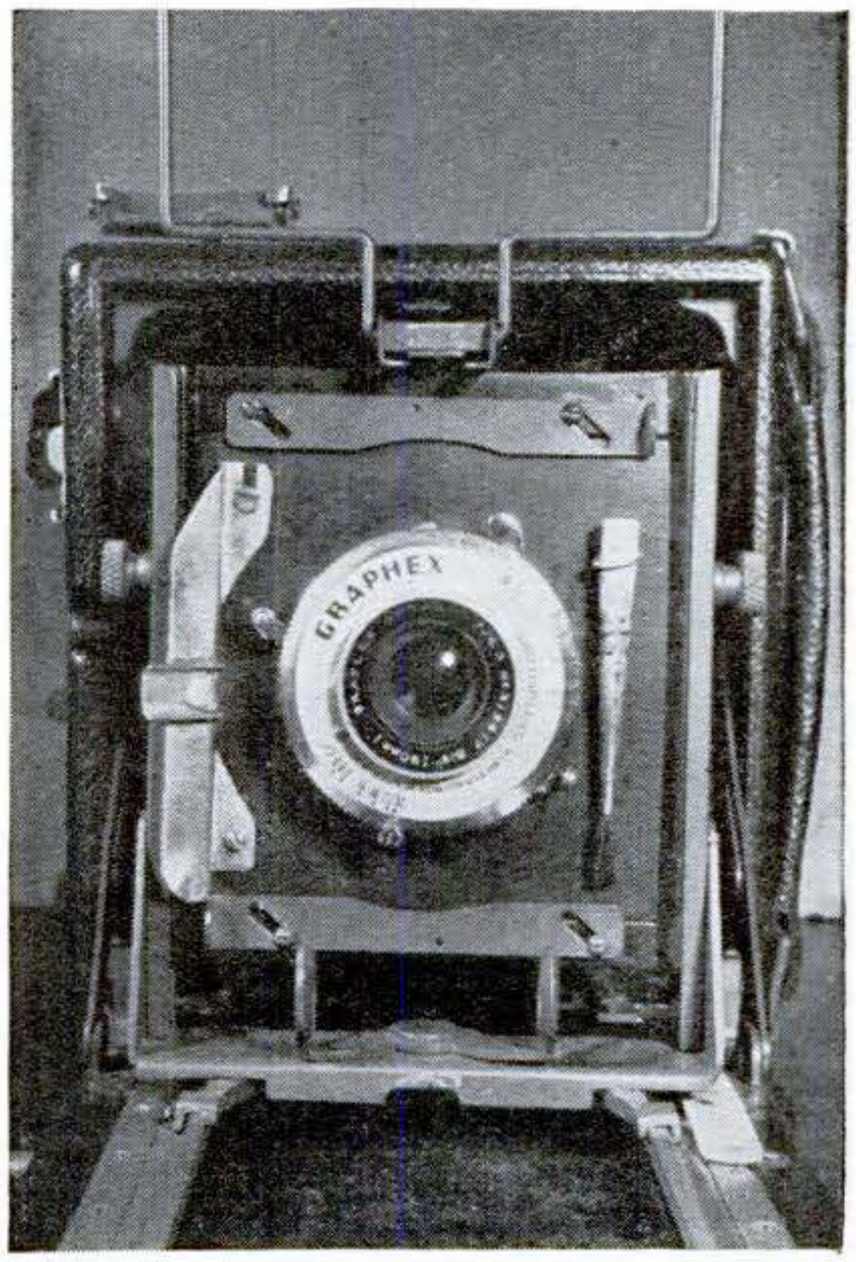
The use of plywood gives strength and light weight. A trunk handle is bolted to the top



ATTACHED TO THE LENS BOARD of your camera, a camel's-hair brush will always be at hand for use when needed to dust the lens. Cut the brush handle off 2" or so above the ferrule, or at the most convenient length, and hold it by means of metal clips or screw eyes.—LOUIS HOCHMAN.

MARRING OF FURNITURE to which flash-lamp equipment is clamped can be prevented by attaching the clamp-on unit over a padding of cloth or cardboard. One convenient pad that you will always have on hand without carrying extra pieces is the corrugated paper sleeve in which an individual flash bulb is packed.—L. H.





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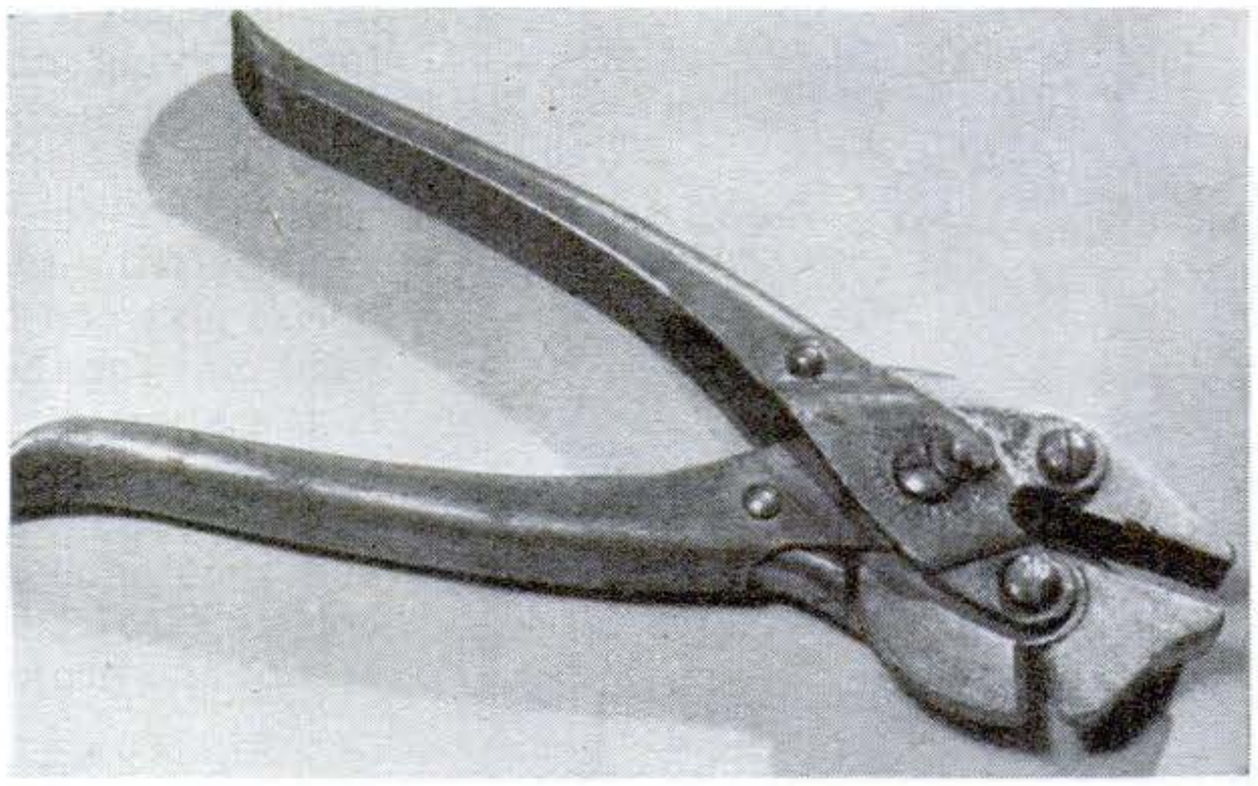
NEW LIFE FOR THOSE



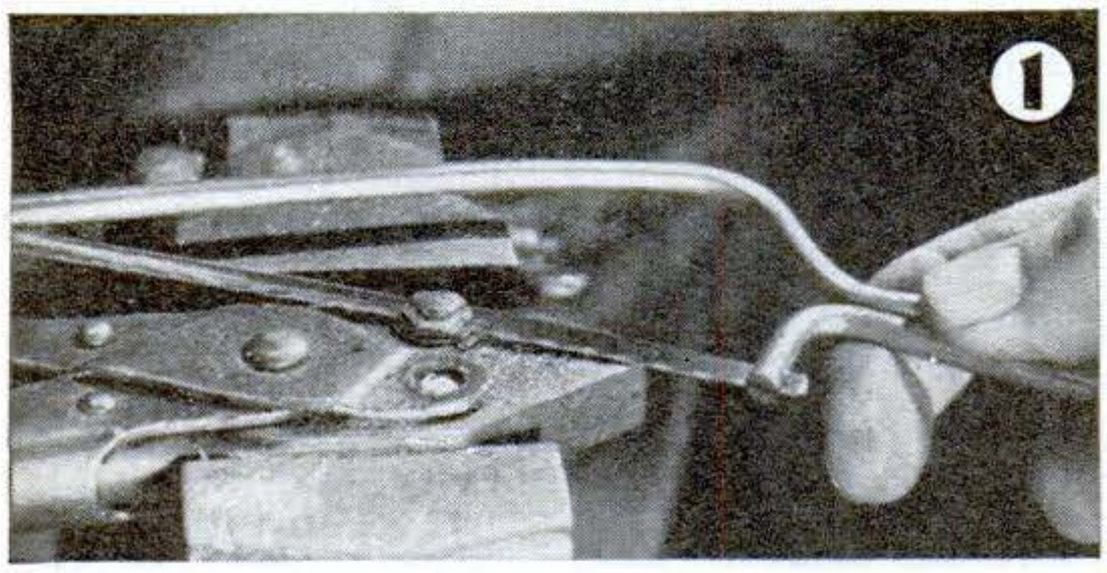
BEFORE rehabilitation these pliers looked their age

NO MATTER what is wrong with your old pliers, the chances are they can be fixed—often in such a way that they will look and work like new. Gripping surfaces can be reknurled if they have worn smooth; pin joints can be replaced; out-of-shape holes in slip-joint pliers can be trued up; and even broken parts can be mended by welding or brazing. If you want to add a special type to your kit, you may be able to pick up what you need secondhand and make a new tool of it by doing your own reconditioning work.

Any repair that requires intense heat will, of course, affect hardness, but this can usually be restored by rehardening and tempering. A brazed handle or jaw may not be as strong as the original, but you can get a lot of service from it if you use a little care. Durable enamel on the handles and other parts that do not come in contact with work will improve appearance and retard corrosion. A bright color, such as red or yellow, will help you to spot the tool quickly on a bench or to find pliers that have been dropped on the lawn.

The secondhand pliers shown above are a type noted for strength and cutting ability. First, the old bolts, which had been riveted and welded by a former owner to keep them in place, were removed by sawing off the nuts, as shown in Fig. 1. This could have been done just as well with a coarse grinding wheel. The pliers were then taken apart and cleaned with emery cloth until most of the original luster was restored. A little oil now and then will help to preserve this finish.

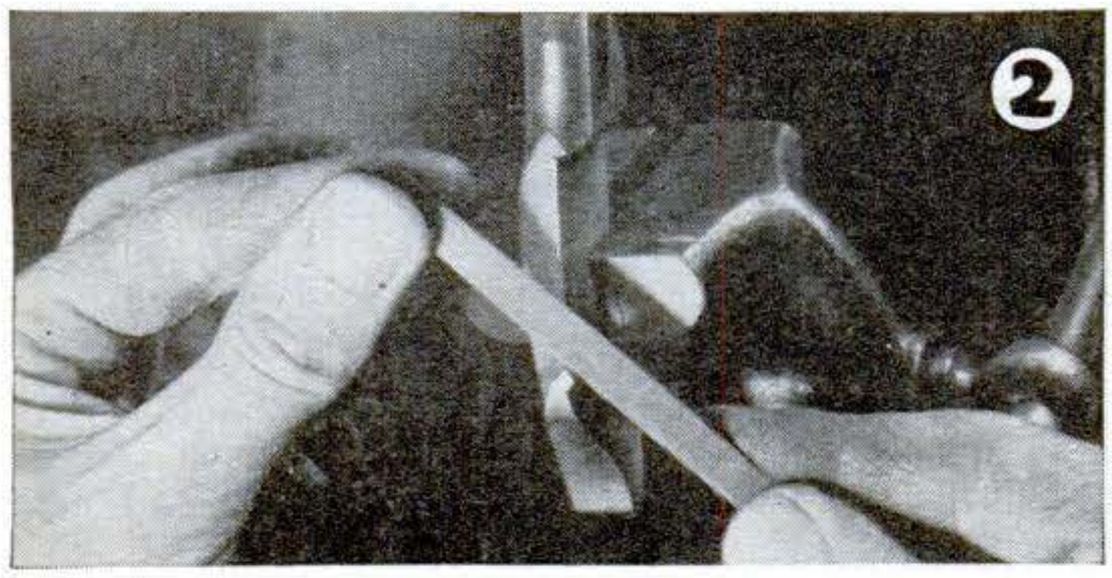
Next, the cutting edges were sharpened

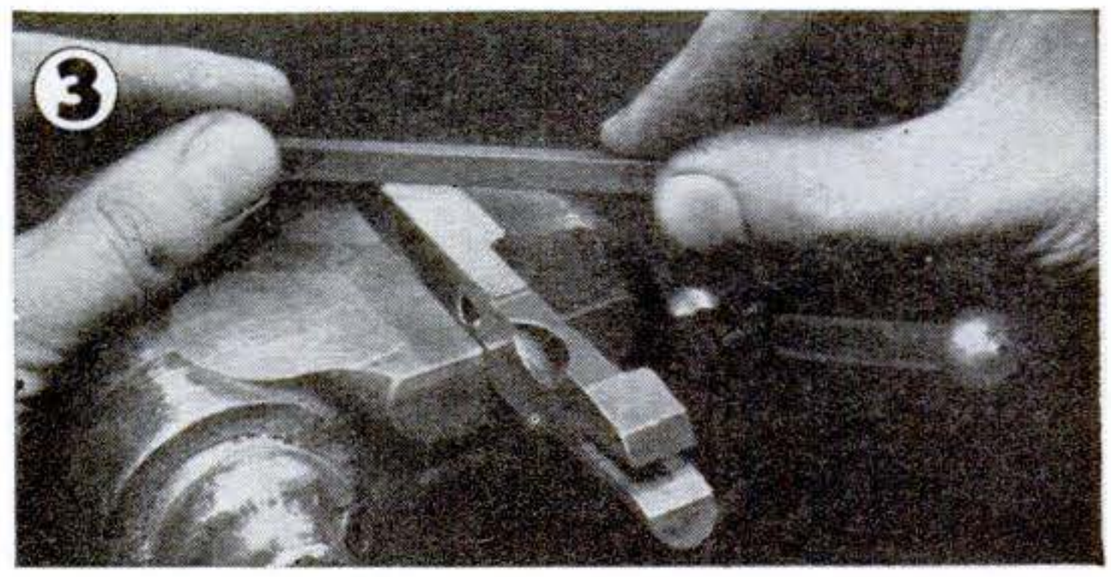


1 Pivot bolts had been riveted and welded to make them hold. The nuts were cut off with the aid of a hacksaw, and the bolts were then pressed out so the pliers could be taken apart

2 Cutting edges, too hard for a file, can be sharpened with an abrasive stick. If they are case-hardened, don't cut down to soft metal

3 When gripping jaws have worn smooth, use a triangular abrasive stick to roughen the surface, following the original knurling marks





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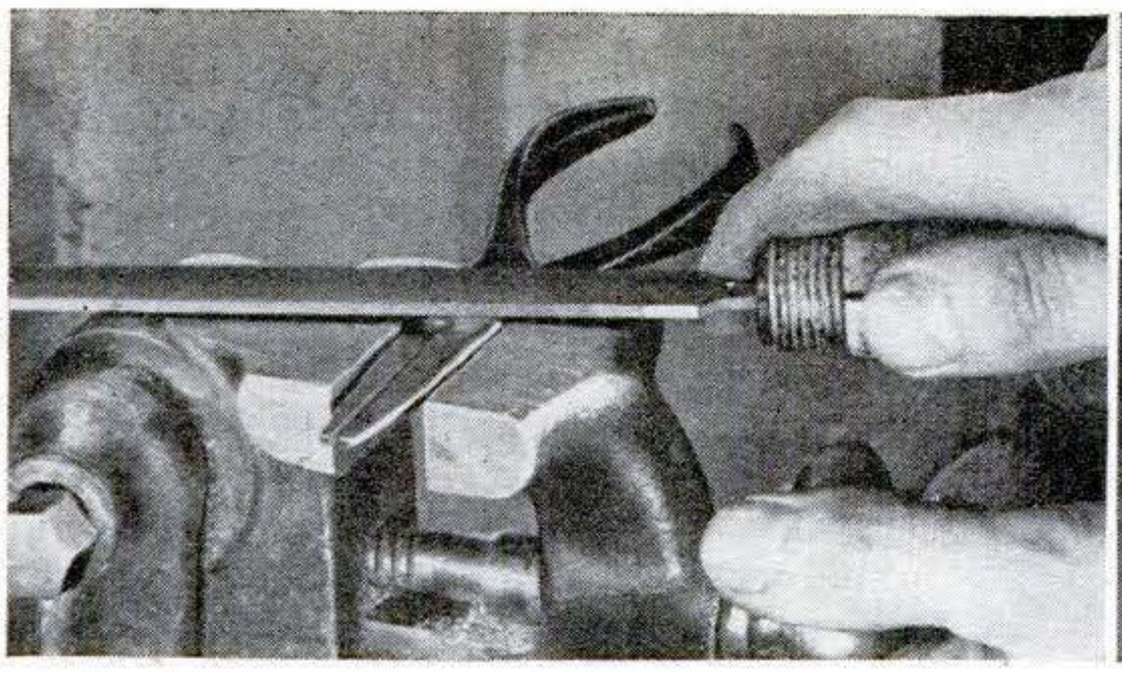
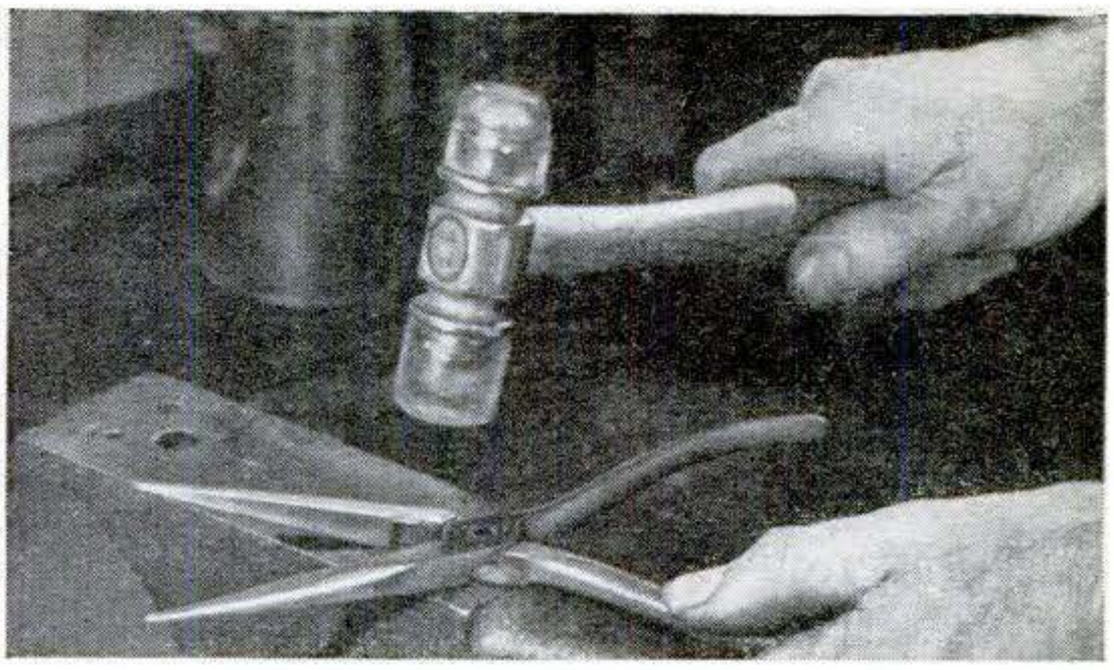


11 After a rivet has been countersunk on both sides of a pivot joint, the heads are filed flush with the surface of the jaws for neatness



12 Long jaws are aligned by hammering lightly while one jaw is supported on each side of the joint. Turn the pliers to tap the other jaw

countersink each piece once more so as to give sufficient shoulder area for the new flush rivet which you will install.

Make the new rivet of cold-rolled or unhardened steel to fit the reamed holes snugly, and cut it 1/16″ or so longer than the original rivet. Peen one end into one of the countersunk recesses with a light hammer, and then repeat for the second end, being careful not to lock the jaws too tight. If a light hammer is used, it is unlikely that the rivet will be upset for its entire length and in that way bind the joint. Finish the peened ends by filing them flush, as in Fig. 11.

The long, slender jaws of chain-nose and needle-nose pliers frequently get out of alignment. One way of remedying this is to lay the pliers so they will be supported at two points ½″ or so on each side of the rivet and then to strike the joint a few times with a plastic, lead, or rawhide hammer. This will bend the supported jaw slightly upward. The pliers should then be turned over and the other jaw given the same treatment. Figure 12 shows the operation with the pliers resting over a hollow spot formed by a shallow ledge in a bench anvil. It may be necessary in some cases to bend the jaws for their entire length. Use care not to strike blows so heavy that you will risk breaking the pliers at the joint.

After repairs that require brazing or welding, harden to suit the kind of steel. If this is unknown, try heating the metal to a cherry red, quenching in water or oil, polishing a bright area, reheating until this turns purple or blue, and then letting the tool cool to room temperature. A mixture of linseed and automobile-engine oil is satisfactory for hardening if you do not happen to have regular quenching oil at hand.

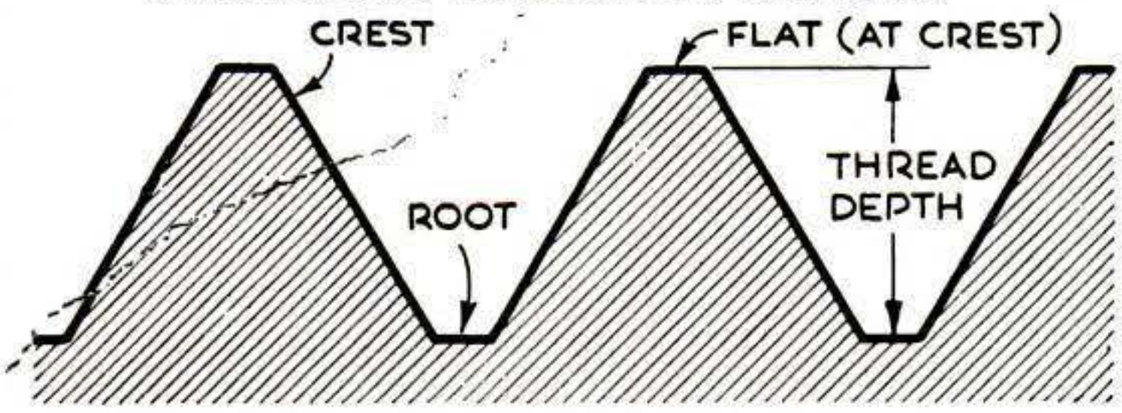
DEPTH OF THREADS

[*SHOP PRACTICE*]

When threads are cut in the lathe with a single-point tool, and when you are using the micrometer collar to regulate the straight-in depth of cut, not the 30-deg. feed, you will save time by knowing the total amount of in-feed (thread depth) required. The table gives single-thread depth for American National threads of various pitch, that is, from the flat of the crest to the root of the thread.

If your threading tool is properly ground, you will obtain a satisfactory thread by cutting to the depth indicated in the table. For a sharp V thread the feed should be somewhat greater to compensate for the absence of flats. This type of thread, however, is not often desirable.

AMERICAN NATIONAL THREAD



Threads per Inch	Depth of Thread	Threads per Inch	Thread Depth of
4	.162″	18	.036″
4½	.144″	20	.032″
5	.130″	22	.029″
6	.108″	24	.027″
7	.093″	26	.025″
8	.081″	28	.023″
9	.072″	30	.022″
10	.065″	32	.020″
11	.059″	36	.018″
12	.054″	40	.016″
13	.050″	48	.014″
14	.046″	56	.012″
16	.041″	64	.010″

Depths are given to the nearest .0005″.

POPULAR SCIENCE MONTHLY SHOP DATA

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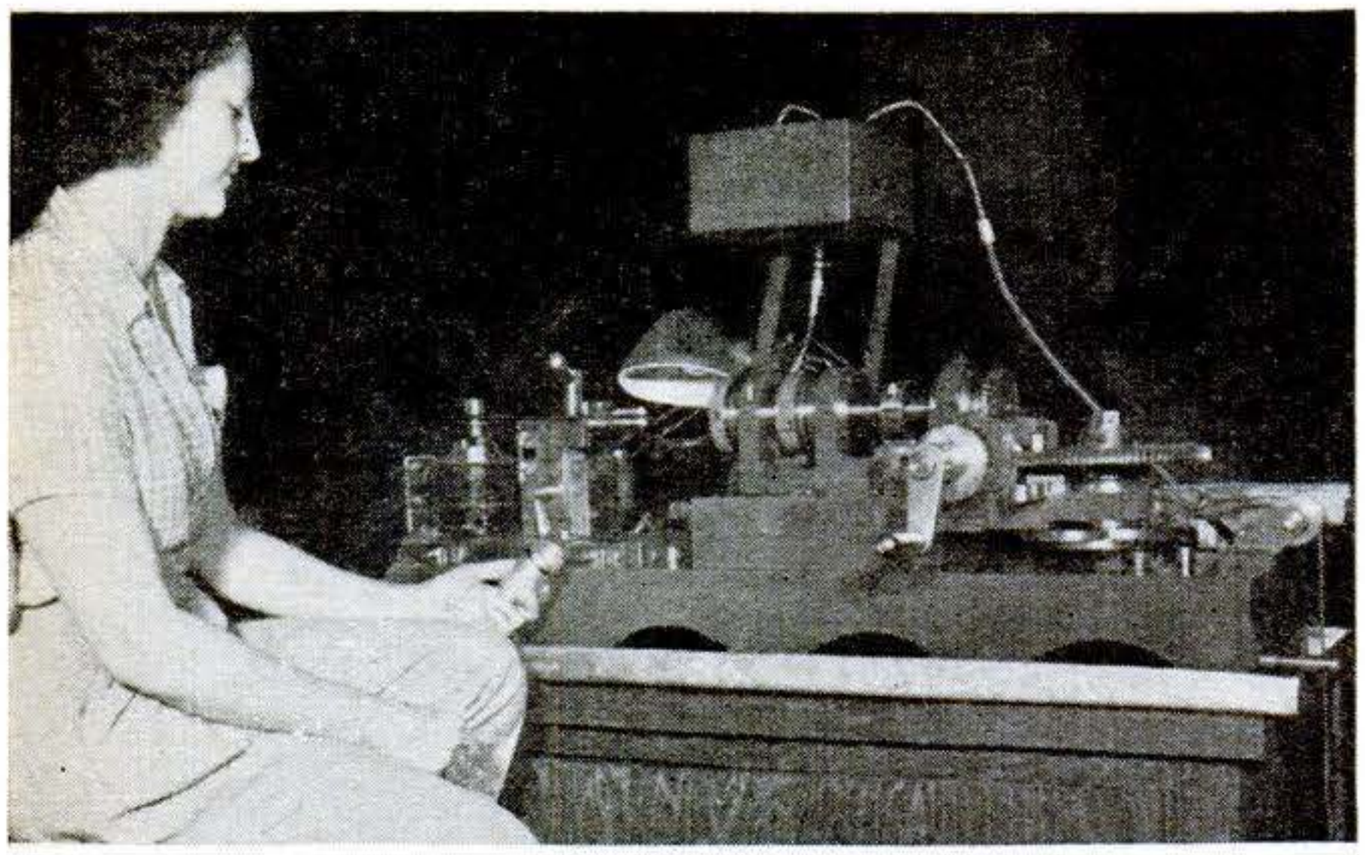
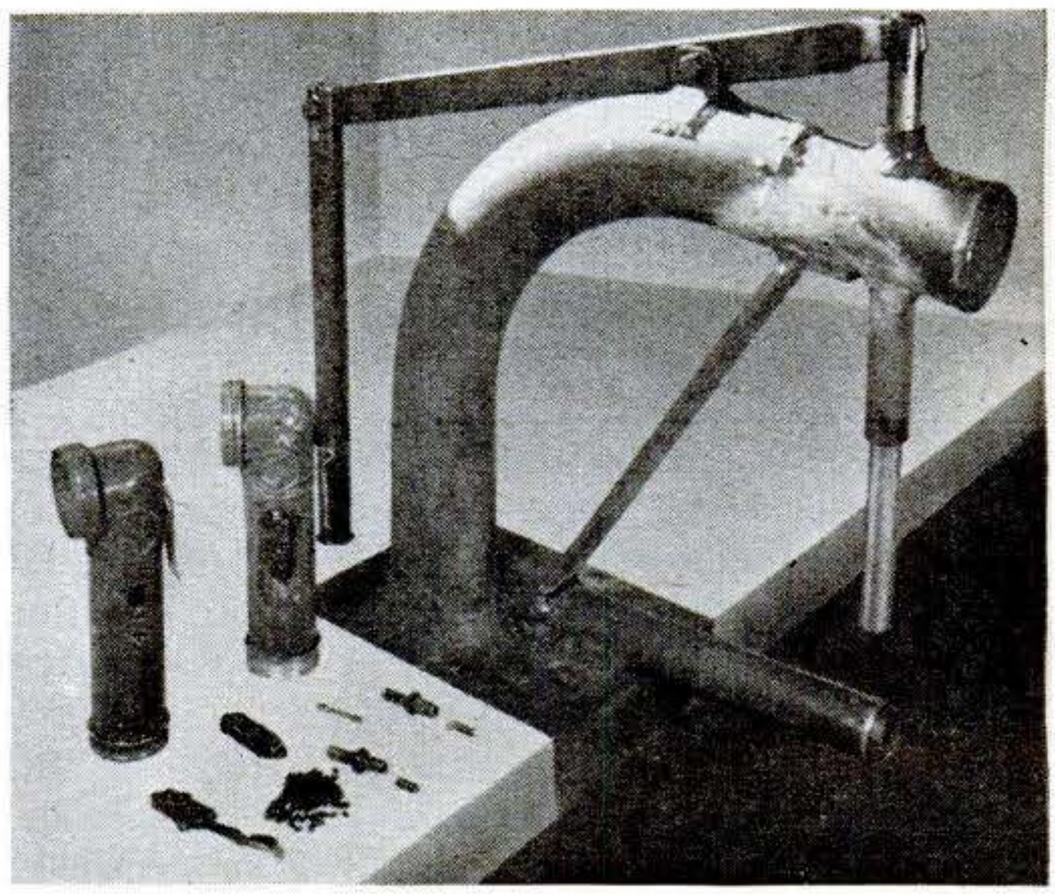
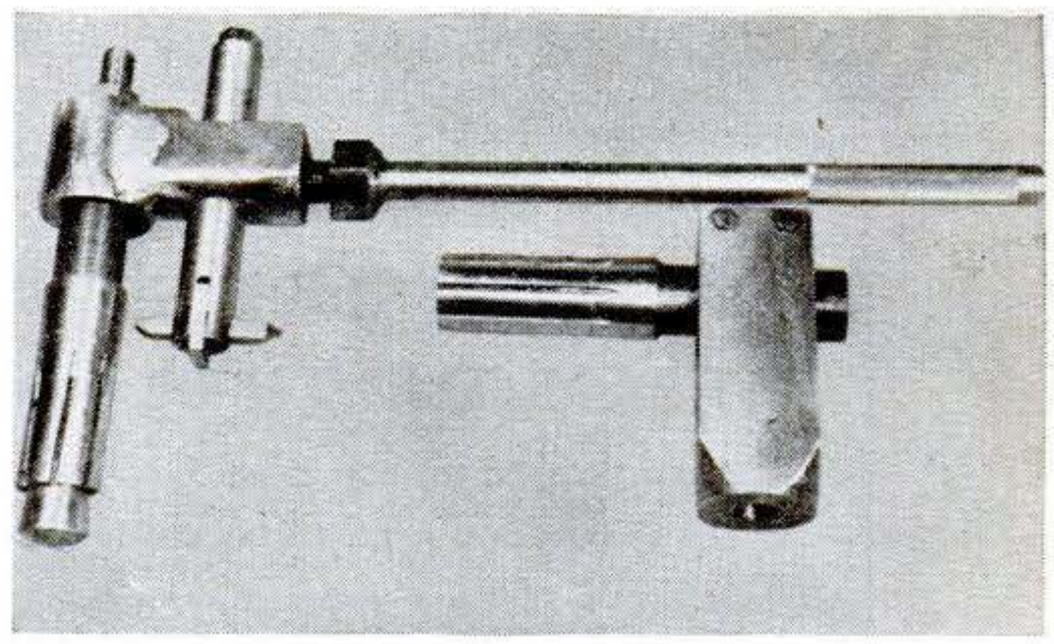


SCRAPPING FLASHLIGHTS because of defective switches has been halted by the machine shown below. The device, made from scrap metal at a cost of $5 by Thomas P. Davis, an employee of the Fort Sill Signal Repair Shop, Army Service Forces, first punches out the rivets that hold the defective switch and then rivets a new switch in place. A new flashlight, even if available, would cost at least 50 cents; a new switch, replaced by this machine, costs but 10 cents. The punch is actuated by a pedal beneath the bench.

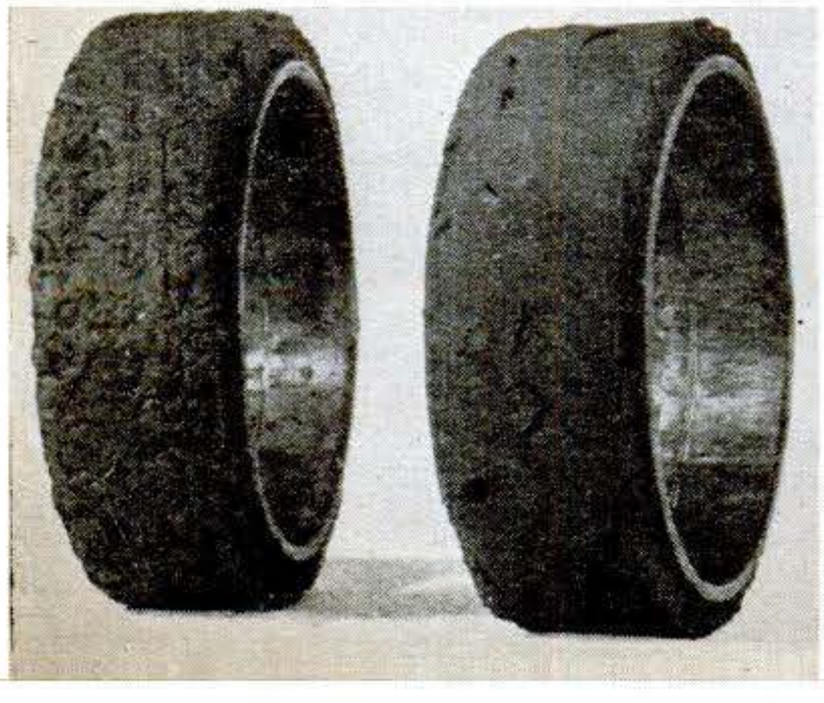
TWO IRREGULAR CURVED TRACKS of minute dimensions are cut in the inside surface of a thumb-sized barrel cam in 15 minutes by a new cam-cutting machine developed by the Fairchild Camera and Instrument Corp., of New York. Formerly, cutting these tracks took 80 hours. The cam is an integral part of an electric gunsight for aircraft. In the above picture, an operator is holding one of the cams and the cutter is in the background. It consists of a 5,000-r.p.m. electric motor, a carriage, a chuck, two master cams, a cutter head, and stationary followers.

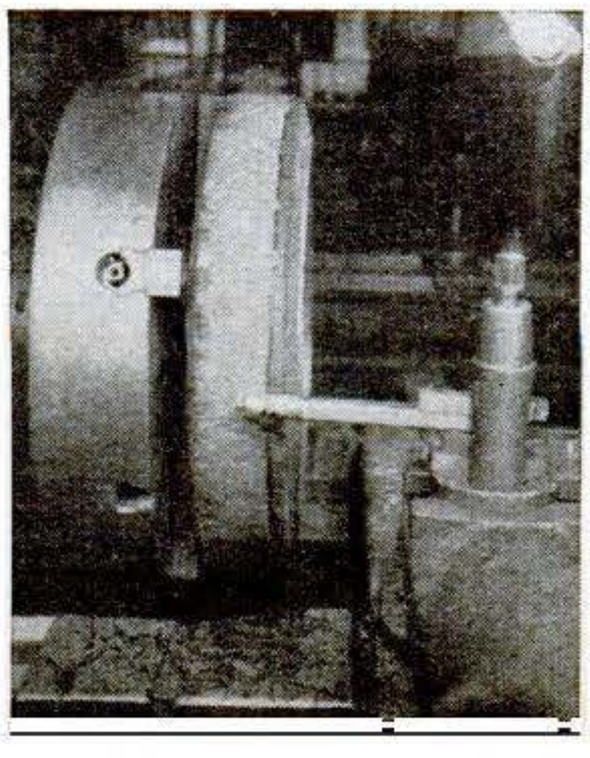


CHECKING ANGLES of flanges is made easy for aircraft workers through the use of one-piece degree plates instead of conventional protractors. Each plate is stamped with large numerals showing the size of the angle. They greatly reduce the chance of a mistake in reading angles. The idea was developed by Henry Benson, of Northrop Aircraft, Hawthorne, Calif.



WORN SOLID TRUCK TIRES are reconditioned at the Warner and Swasey Co., Cleveland, Ohio, by removing the high spots in a lathe. Although some rubber is cut away, the life of the remaining rubber is prolonged because the smooth contour insures a more uniform distribution of the load. Efficiency is also increased since the truck can operate once more at normal speeds.





DAMAGED THREADS of truck axle housings may be repaired without removing the parts from the trucks through the use of the hand-powered die that is shown above. It was devised by Elmer C. Adams, an employee of the Army Service Forces motor-maintenance shop at Fort Sill. He built the die from scrap steel at a cost of $25. It is claimed that an annual saving of $1,140 has been effected as a direct result of using this tool in the motor-maintenance shop.

POPULAR SCIENCE

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CLAMP TOOL KNURLS SLENDER WORK

By C. W. Woodson

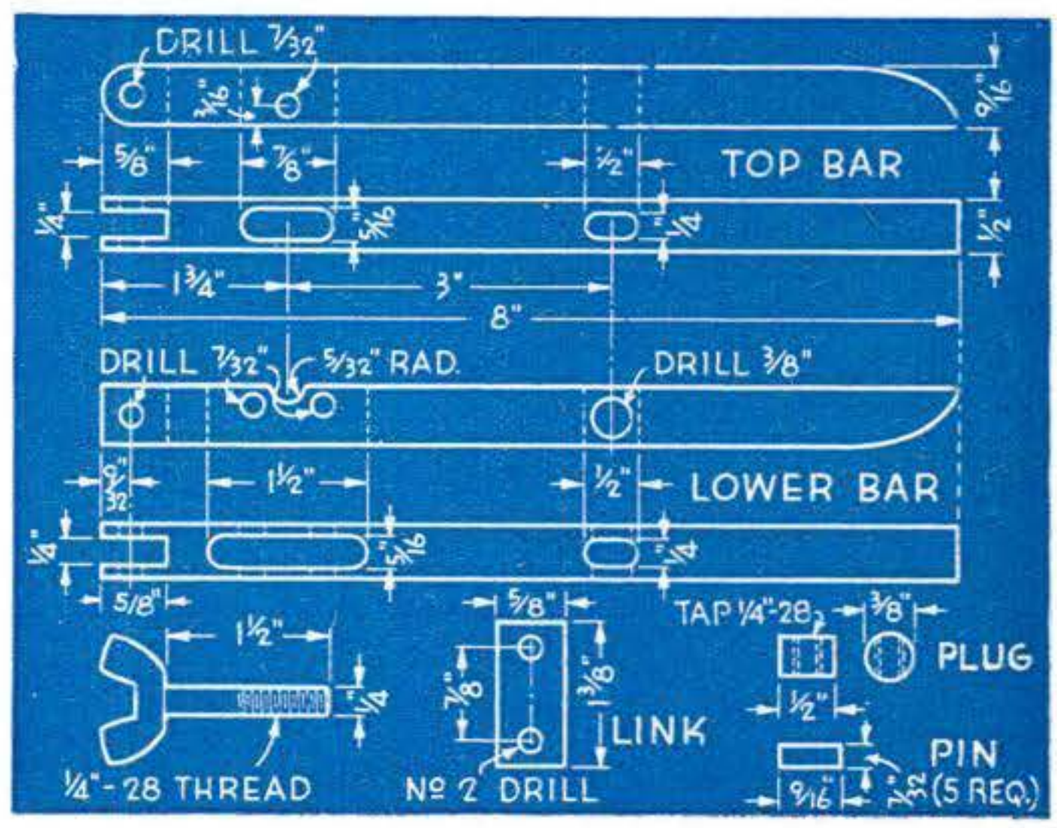
LONG, slender parts can be worked readily with a knurling tool of the clamp type shown here. The knurls are sunk into the workpiece from both top and bottom when the wing screw is tightened, thus eliminating the heavy side strain that springs slender work when knurling is done in the customary way. Hold the tool in your hand and run the lathe at its lowest back-geared speed. Keep both the work and the knurls well covered with oil. Practice shows the best depth at which to tighten the screw.

The knurl holder is two short lengths of ½" by 9/16" cold-rolled steel hinged with a pinned link that gives a floating action to the knurls and permits them to adjust themselves accurately for centering the work. Slots for the knurls can be made in the drill press with a 5/16" end mill. Cut a slot in the end of each bar for the link with a ¼" end mill. The elongated holes for the wing screw can also be cut with the ¼" end mill. Holes for the link and knurl pins are drilled undersize so that these must be driven in.

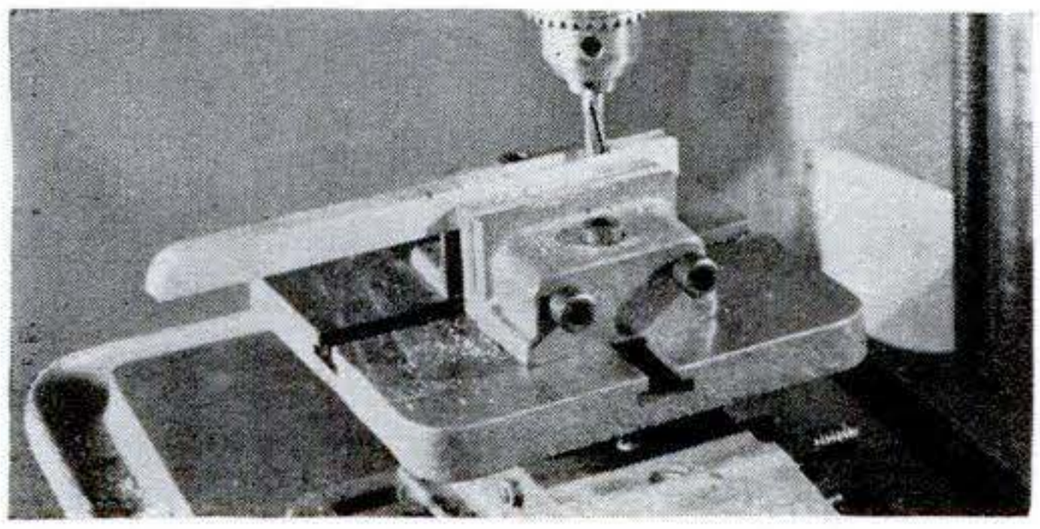
Three hardened and tempered tool-steel knurls should be purchased. The holes for pinning them are laid out in the drawing for ¾" diameter knurls. If the size of those you obtain differs from that, space the pin holes so the two lower knurls will be close together and near enough to the upper edge of the bar for the knurls to clear and reach the work. The upper knurl is centered between the two lower ones, its pin also being located close to the edge of the bar.

A short plug is made up, drilled, and tapped to receive the tightening screw. It should swivel freely in the hole drilled at right angles to the elongated screw hole in the lower bar.

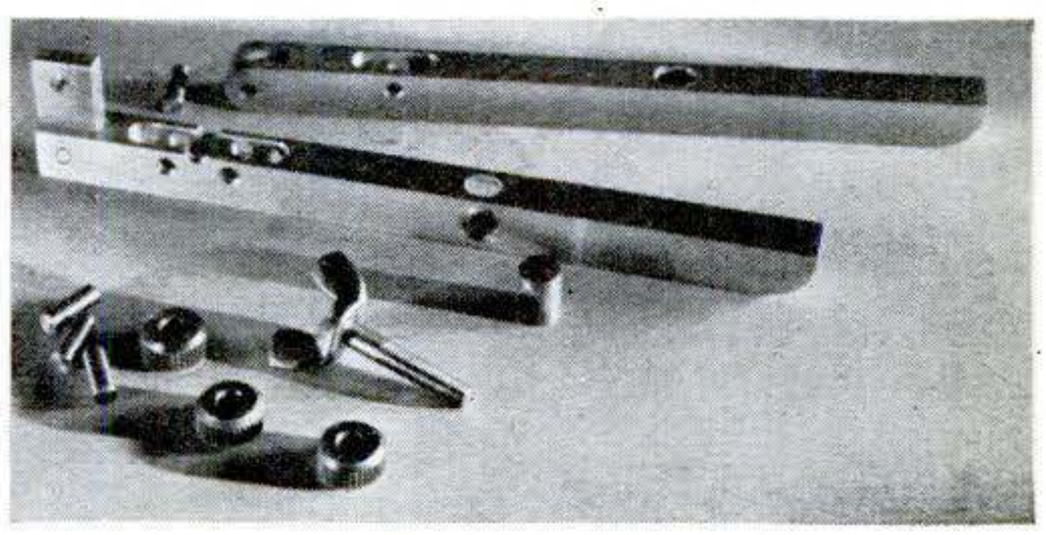
All pins are short lengths of 7/32" diameter drill rod, which should allow the knurls to turn freely. Holes in the link of the size specified permit easy swiveling.



Slots for knurls, hinge, and tightening screw are cut in both handles with end mills chucked in the drill press. That for the hinge is filed square



All parts of the knurling tool are shown below, with the hinge link pinned to the lower bar. The link must be just under ¼" thick for free action



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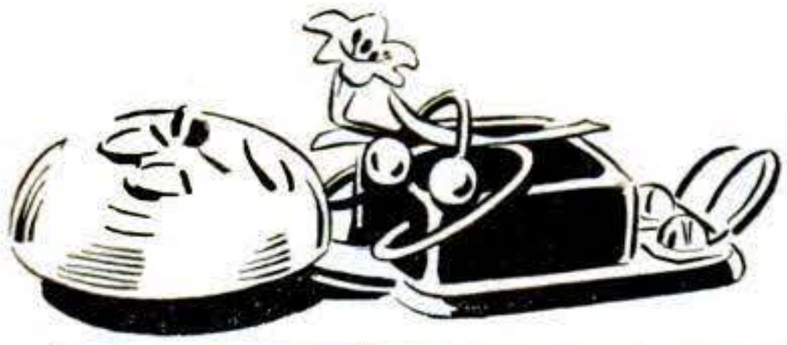

Is Your Doorbell

By TRACY DIERS

Door chimes rarely get out of order, but they will not work if your battery or transformer is dead or if the wiring is shorted

If dry cells operate your bell or chimes, slide off the covers and look for white spots where the zinc has been eaten away. Test cells that seem good by touching wires to your tongue

Another way to test dry cells is with a flashlight bulb connected to the terminals. A transformer should be tested with a small bulb or with a wire shunted across its terminals (right)

HIGH up in the list of annoying if minor troubles that beset householders is the doorbell that refuses to make a sound, however vigorously the button is prodded. Almost as exasperating is the bell that responds only occasionally—when it feels like it. Either of these tricks of recalcitrant doorbells can cause real annoyance if a friend can't summon you to the door, or if a deliveryman must go off with an undelivered package.

With almost no equipment, but with a system, any novice can tackle the job of putting a dead doorbell back on its feet. The system is this: (1) test the source of the current; (2) test the push button; (3) test the bell itself; and (4) test the wiring for shorts.

Dry-cell batteries are the usual source of bell current in old houses, transformers in more modern ones. Slide off the covers of dry cells and look for large white spots where the zinc jackets have been eaten through. Any cells with these spots should be replaced. The others should be tested separately by connecting a short length of wire to each terminal and trying the ends with your tongue, an iron file, or a two-cell flashlight bulb. You will get a strong, sour taste, a spark, or a dim light from a good cell. In connecting up the cells again, be sure to put them in series.

Test a transformer with a short wire or an automobile dashlight bulb shunted across its terminals while the regular circuit wires are disconnected. If you don't get a spark or a light examine the 110-volt line to the transformer; if this is in good condition the transformer is burned out and must be replaced. It will be well to describe your bell or chimes to your dealer in electrical supplies so you will be sure to get a new transformer of the proper voltage. Bell transformers are designed to give current only for short periods, so make your tests brief and not too frequent.

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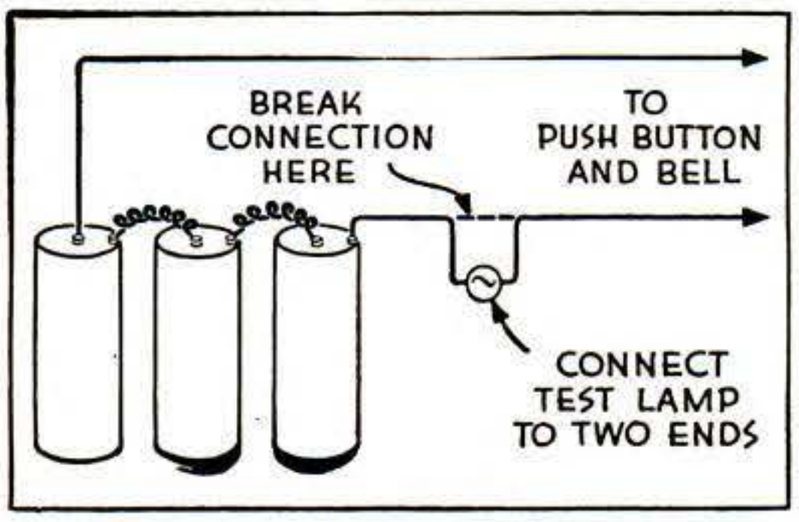
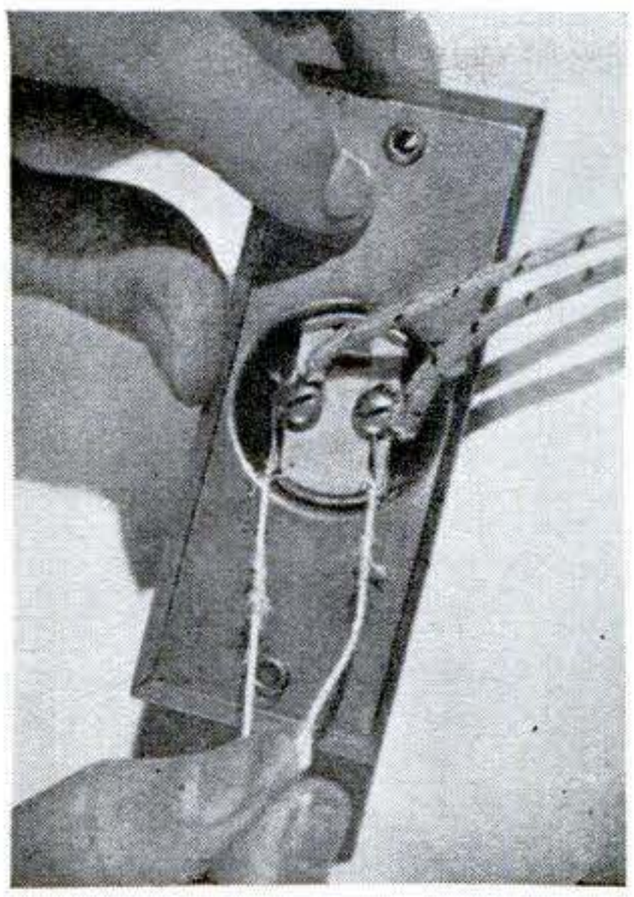
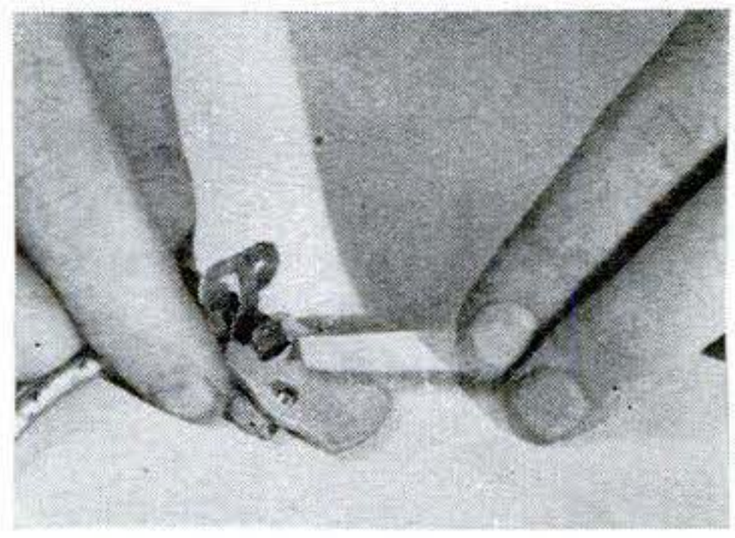
Dead as a Doornail?



A bulb helps to locate a short. The cells are shown wired in series



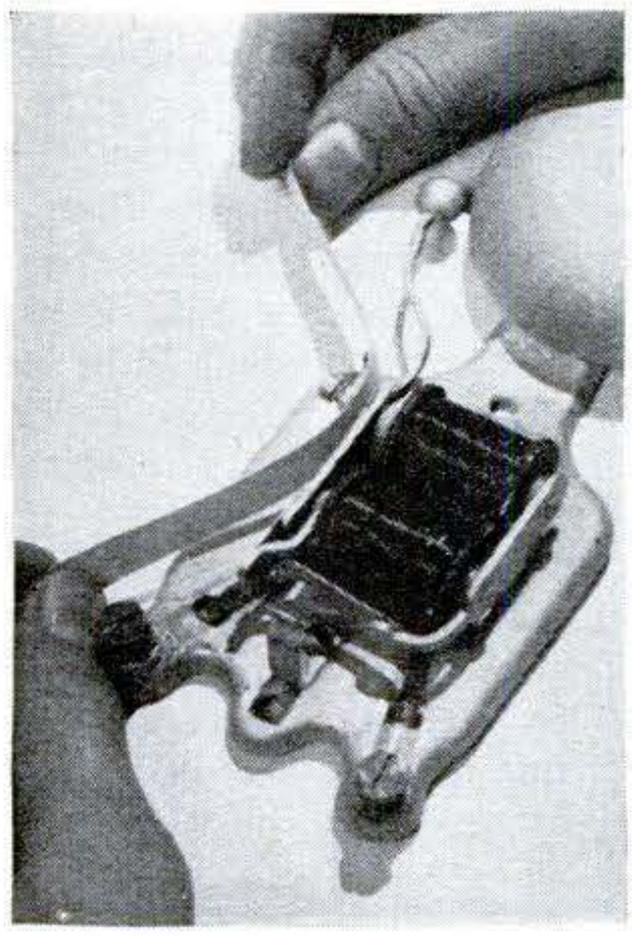


Test a push button by placing a wire across its terminals, as shown at the left. If this causes the bell to ring, the contacts inside the button should be cleaned with fine sandpaper. Make sure the button terminals are tight

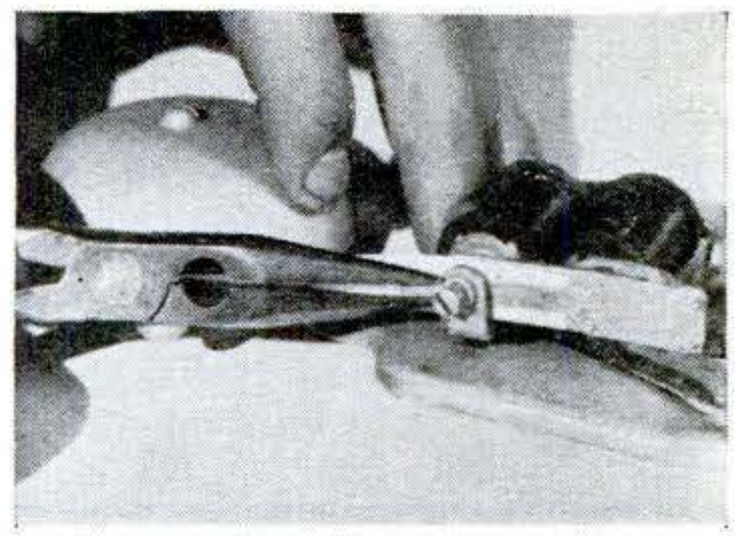
Remove the push button and place a wire across its terminals to check it. If this makes the bell ring, the button points may need cleaning with fine sandpaper, or they may require bending to make contact. A spark and no ring may indicate a short or a failure of the contact points in the bell to break. Disconnect the wires at the bell terminals and test the push button again. A spark this time is a sure indication of a short. If there is no spark, examine the bell.

Some accident may have bent the stationary contact point against the other in the bell so that they cannot break, or vibration may have loosened an adjustable contact screw. Either can be easily corrected. But first put an automobile dashlight bulb across the wires taken off the bell terminals. If the bulb lights when the button is pressed, current is available and the wiring and push button are all right.

Connect the wires to the bell terminals again and have somebody push the button while you watch the bell. If the clapper moves but strikes the bell only once or not at all, the vibrator contacts are not breaking correctly. Loosen the lock nut with pliers and turn the adjustable contact screw counterclockwise to draw it back slightly from

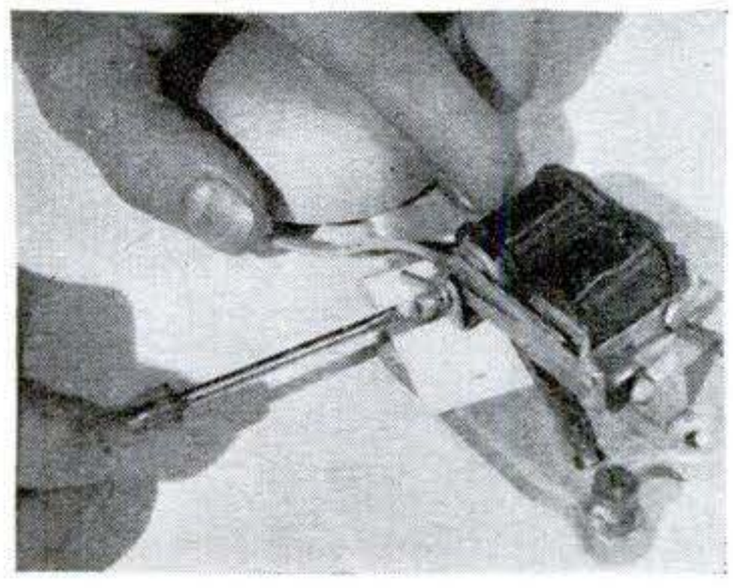


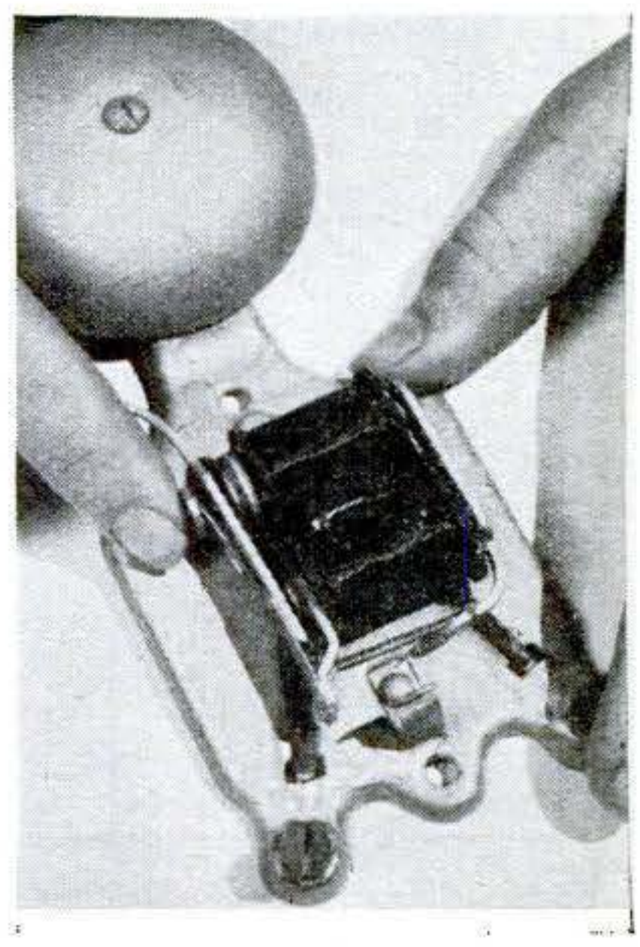
Clean contacts are also a first requisite in the bell itself. Run a stick of fine sandpaper between the vibrator points; then loosen up the lock nut to adjust the gap for the best bell sound



If your bell has no lock nut and adjusting screw, you can set the contact-point gap by gently bending the fixed bracket with one finger, as at right below, until the bell rings as loudly as desired

Counterclockwise turning of the adjusting screw corrects for faulty breaking of the vibrator points, while clockwise turning closes up points that don't touch. Turning also adjusts the tone and volume





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Although chimes are protected by a cover, kitchen grease may work in. Check the plunger to see that it rides easily in the solenoid. If it doesn't, wipe it with cleaning fluid

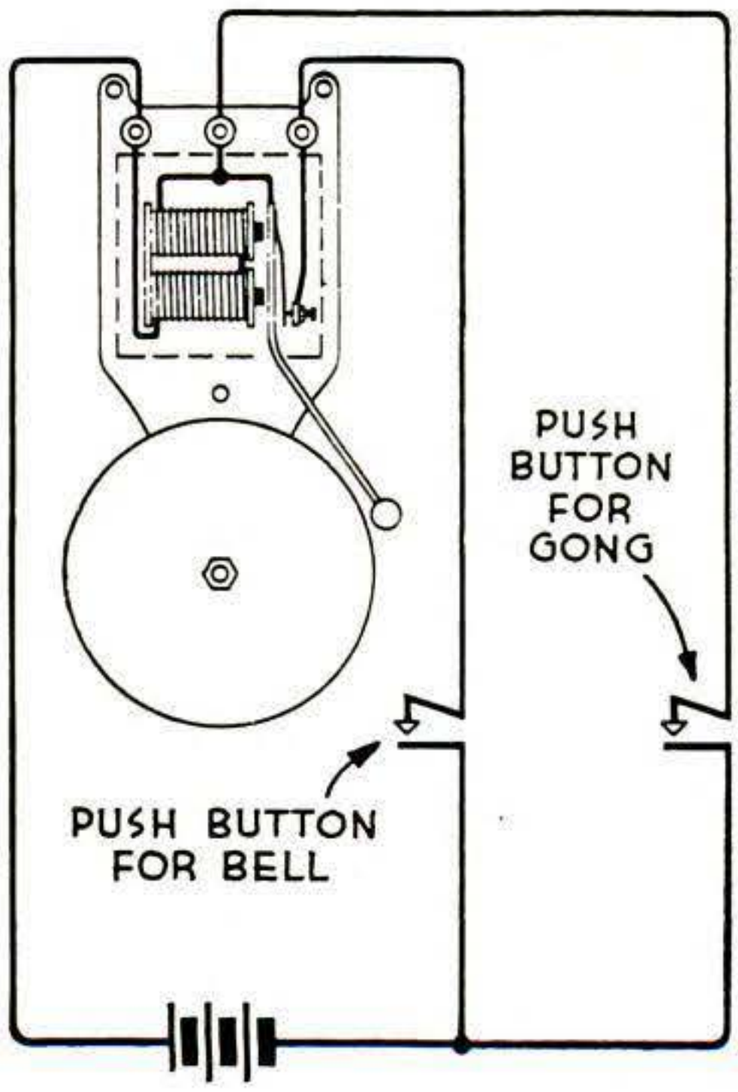
the contact on the clapper arm; then try the bell again. If it vibrates but the clapper does not hit the bell, bend the thin part of the clapper arm slightly. Adjust the points to produce as rapid a vibration as possible.

If the clapper does not move at all after the wires have been reconnected, the points may be dirty. They should be cleaned first of all with fine sandpaper. If they do not touch when the clapper is at rest, loosen the lock nut on the adjustable stationary contact and turn the screw clockwise while someone presses the push button. When the bell starts ringing, tighten the screw to adjust tone and volume. Bells that do not have screws and nuts can be adjusted by pressing the stationary bracket toward or away from the vibrating armature.

Occasionally the armature may adhere to the magnet poles. Pull it free carefully and try the bell. If it rings, note whether the armature again sticks. It may be because of a slight residual magnetism, which can be overcome by a piece of thin paper pasted on the pole faces of the magnets. This prevents metal-to-metal contact and forms just enough of a gap to prevent adhesion.

Door chimes rarely get out of order because they have no sparking parts, but, of course, the battery or transformer, the push button, and the wires may develop the usual troubles. Chimes operate by current passing through a solenoid that sucks a plunger in, and this plunger hits the chime. Check the plunger to see that it slides freely. Wipe off dust and grease with dry-cleaning fluid.

To test for a short circuit after determining that the battery or transformer is good, remove a line wire and connect your test bulb to it and to the source of current. If the bulb then lights up, there is a short, and every inch of wiring must be checked to find it. Look especially for places where insulation has been scraped off, and tape them. The light will go off when the short has been corrected. Although this checking is tedious, it may repay you if your wiring is old, for a short can discharge a battery or burn out a transformer.



Trick Hookup Provides Two Signals

WHERE callers may come to either a front or a back door, it is usual to connect a bell to one push button and a buzzer to the other so the tone will tell which door is to be answered. However, if only a bell is at hand, or if still a third entrance is being used, a trick circuit will afford two distinct sounds from one ordinary bell.

All existent wiring is left intact, but from that side of the battery connected to the first push button a new wire is run to the second push button. From the other terminal of this button a wire is run to the bell, but not to a terminal. It is connected instead, either by soldering or by securing it under a screwhead, to that end of the coil winding that goes to the vibrator points. This connection will cause the clapper to strike only once. It may be necessary to bend the clapper arm slightly to obtain a clear note. Check to be sure the bell also rings normally.

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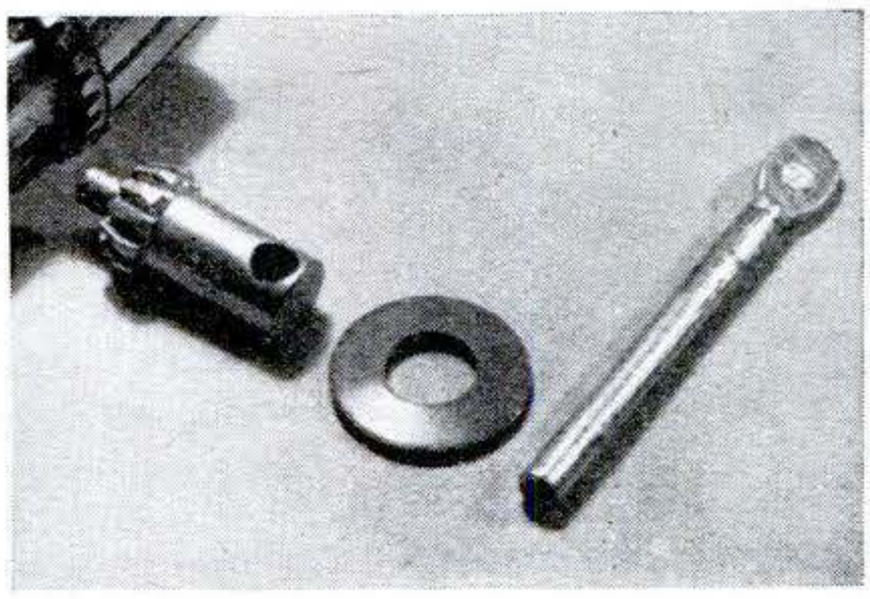
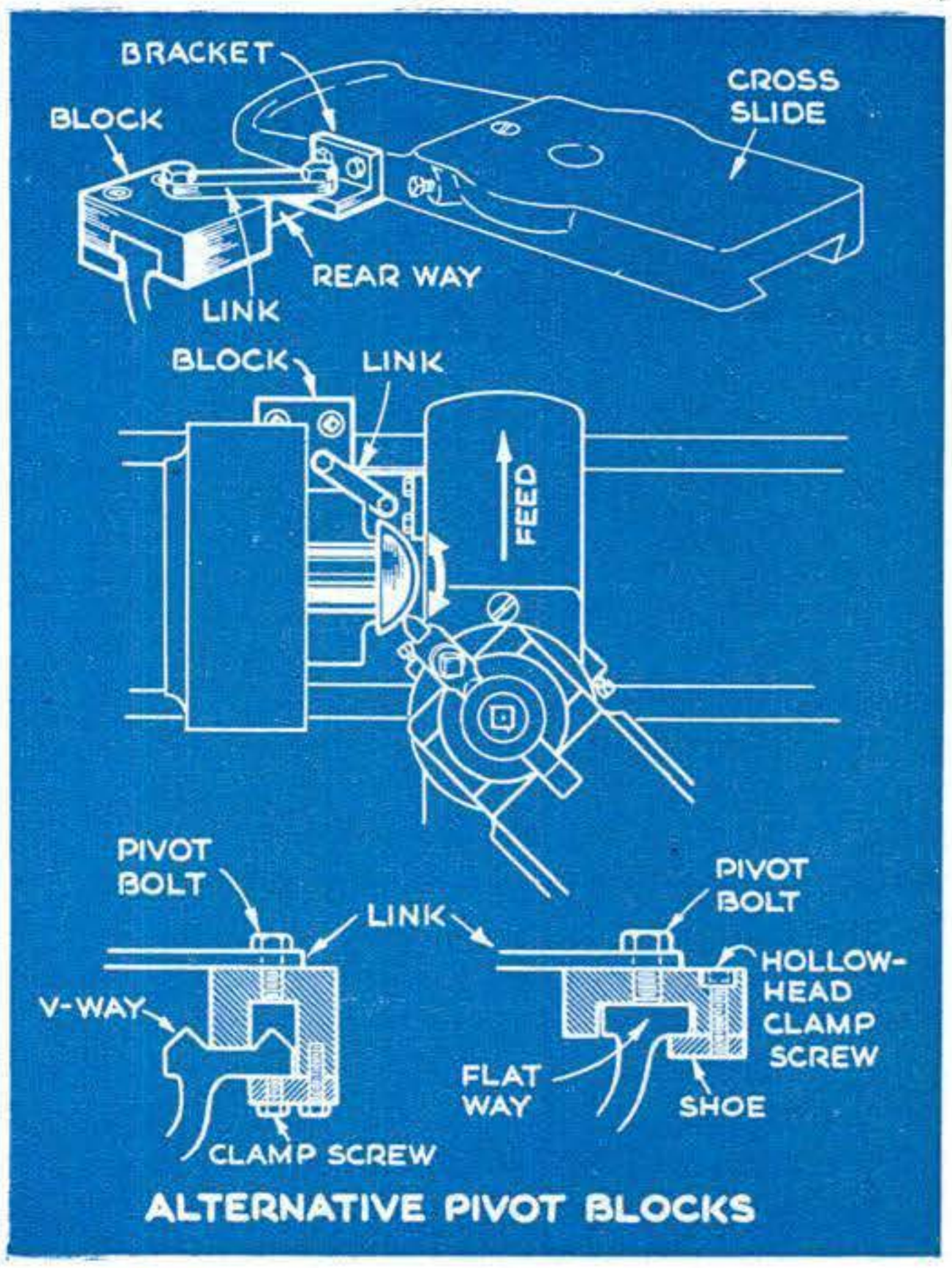
KEY-TYPE CHUCKS are dangerous because an operator's fingers may be severely pinched between the teeth on the chuck and key. To prevent such mishaps, install a large washer on the key shank so it will act as a shield. Ream or turn the washer hole to a diameter that permits it to fit either loosely or tightly on the shank, according to your preference; then drive the key handle out of its hole, slip the washer over the shank, and replace the handle, driving it in firmly.—W. E. B.



Courtesy of Warner and Swasey Co.

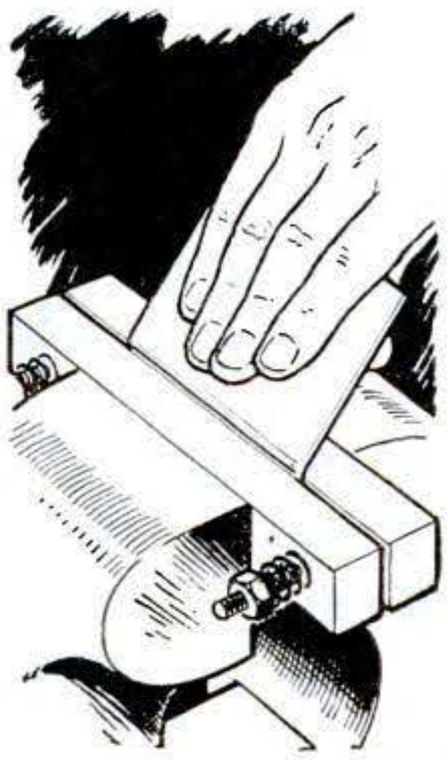
SPHERICAL HEADS may be produced on a large quantity of duplicate parts with the accessory shown at the right. Bolt an angle bracket to the face of the cross slide and mount a suitable pivot block on the rear way of the lathe. Two alternate types are shown at the right—one for a V-way, the other for a flat way.

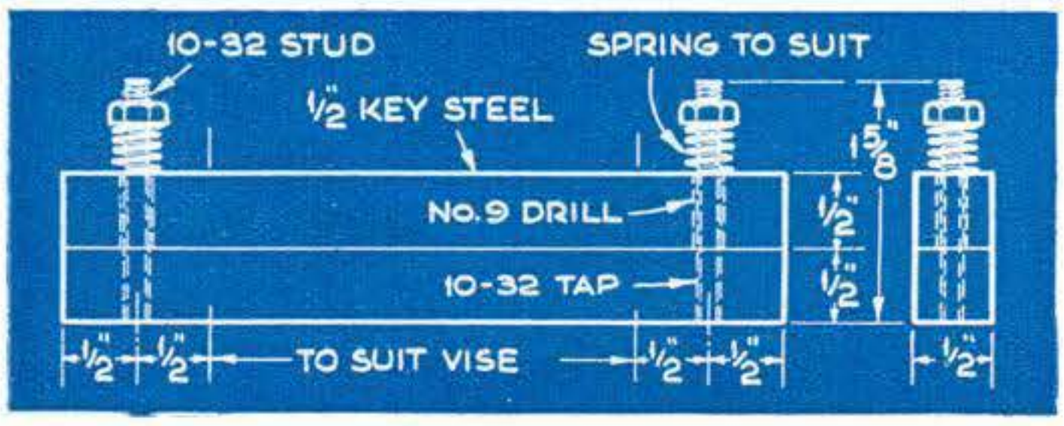
Make a flat link of appropriate length and drill a hole at each end of it, spacing the two holes a distance apart equal to the radius to be machined on the work. Mount the link by means of two close-fitting pins or bolts that thread into the pivot block and angle bracket respectively. As the cross slide is advanced, the swivel action of the link moves the carriage along the lathe ways in such a manner that the tool bit travels in an arc.—R. WASHBURN.



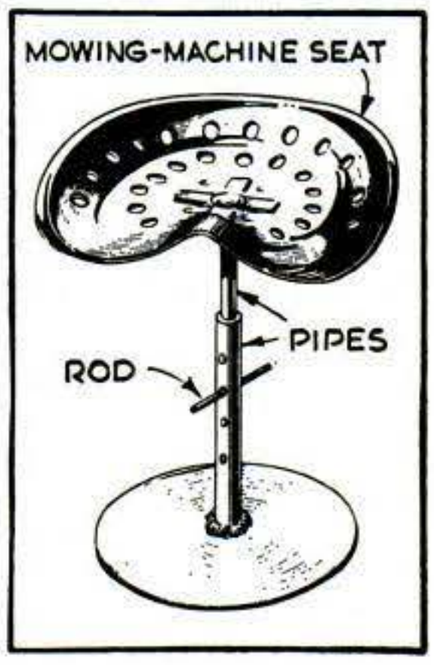
ALTERNATIVE PIVOT BLOCKS

FOR BENDING small parts, this jig is ideal. It consists of two ½" square steel blocks, which are fastened together with studs, as shown. To use it, slip the stock to be formed in the jig, line it up, secure the jig in a vise, and bent the material to the shape you wish. —W. E. KOTTMEIER.





WELDERS will appreciate this adjustable stool, suggested by *Oxy-Acetylene Tips.* Weld a length of pipe to an old farm implement seat. This slides in a second pipe of larger diameter, which is welded to a round scrap-plate base. Drill several holes through the outside pipe and one, slightly larger, through the inside one. Insert a welding-rod stub in the appropriate holes to hold the seat at the desired height for the job at hand.



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This equipment sends and receives civilian-defense messages at R.F. frequencies on A.C. power lines

Hitching

HOW CARRIER-CURRENT COMMUNICATION

By JOHN W. CAMPBELL, JR.

BECAUSE it costs a good deal to string even a single wire over any considerable amount of landscape, telephone and telegraph companies have developed various means of sending two, four, or even several hundred messages at the same time over one conductor. One of the most interesting is called "carrier-current communication." This is really nothing more than wired wireless, for it consists of harnessing radio waves to a conductor instead of broadcasting them freely from an antenna.

With the parts of two honorably retired radios, a few extra gadgets, and a single homemade coil, you can rig up a carrier-current outfit for communication over your electric power lines. You can place the sender in the nursery, take the receiver along while visiting neighbors, and then hear the baby if it should wake up while you are in the middle of your bridge game.

All the radio stations in the world put their signals into a common ether, from which any desired signal can be unscrambled by means of a receiver tuned to the right frequency. In the same way, if six or six hundred signals of different frequencies are led into a copper wire, they can be taken off one at a time by suitable tuned circuits. Electric power companies send a constant 60-cycle signal along their mains—the power itself. But they also feed in signals at 50,000 to 100,000 cycles per second, which are audio modulated like the carrier wave of a radio station. Thus the engineer at one power station can communicate with another by means of a suitably tuned sender and receiver.

Amateur radio communication requires a license and is entirely prohibited during wartime, but carrier-current communication does not require a license so long as the carrier wave is not "broadcast." The FCC defines broadcasting in terms of the amount of energy detected at a certain distance from a wire or antenna. So long as the output is limited to 10 watts and the frequency is kept between 150 and 200 kc., a carrier-current transmitter will be within the permitted range.

Lower frequencies should not be applied to

Note the hand-wound coil at extreme right of the transmitter chassis. The six turns of the secondary are wound over the primary

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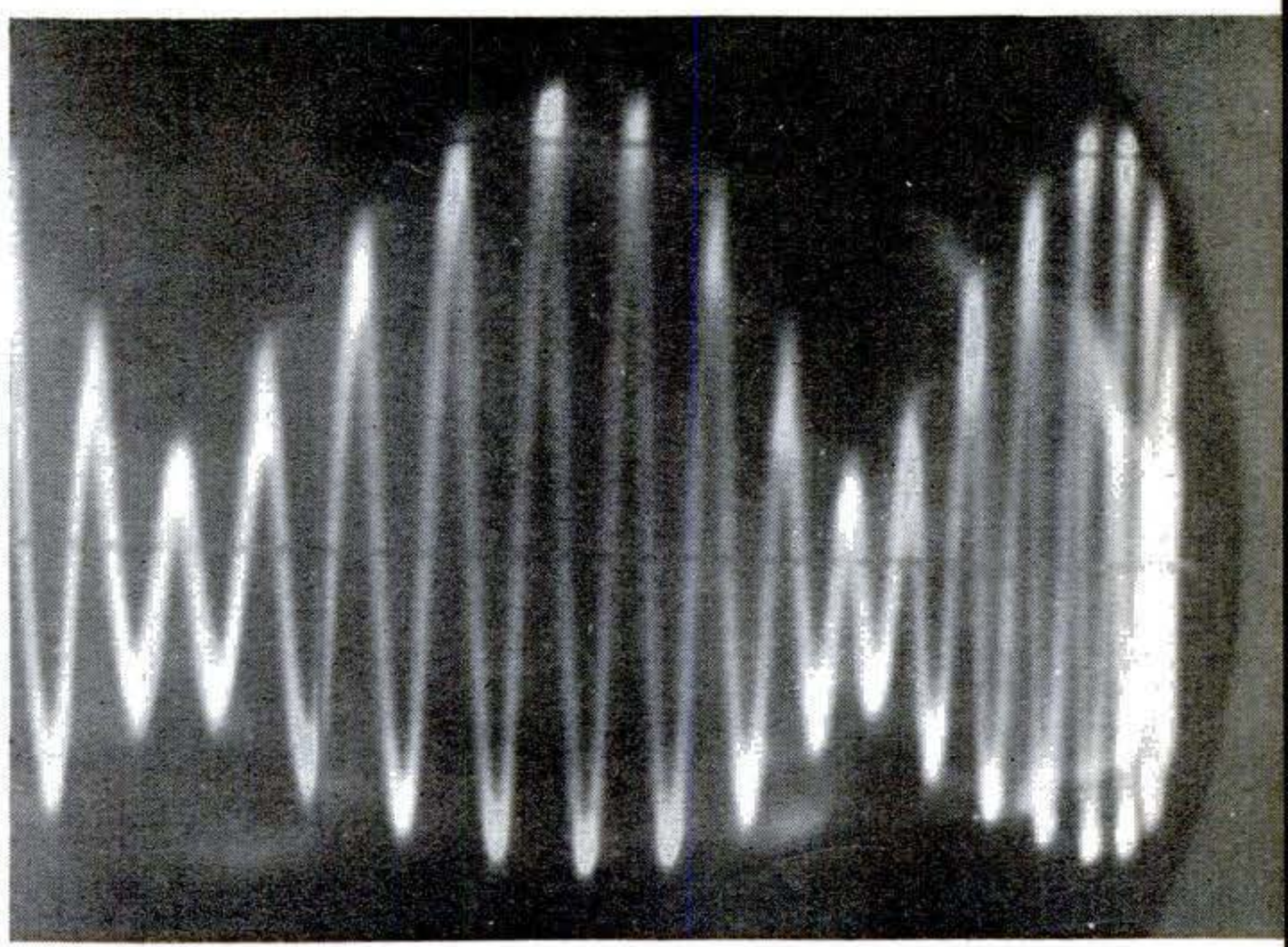
Radio Waves to a Wire

WORKS . . . SHORT-RANGE EQUIPMENT CAN BE BUILT FROM STANDARD RADIO PARTS

power lines, as power engineers need such lower bands for communication. Higher frequencies may radiate and bring stern inquiries from the FBI. *Caution: In certain strategic areas, no unlicensed communication whatever is permitted.* Therefore, before setting up any equipment, inquire of your local War Emergency Radio Service whether your area is so classified.

The carrier-current receiver is merely a conventional radio, with one difference: it has fixed tuning adjusted to its associated transmitter, since you are interested in getting only that one "station." Construction of this receiver will be taken up in a following article.

Save that the transmitter is connected to your house power line in-instead of an aerial, it is just like a low-power radio transmitter. *Don't* connect it to an aerial. Government monitors are constantly listening for unlicensed stations, so that going on the air will surely get the unwary experimenter into trouble.



An oscilloscope picture of 180-kc. R.F. waves, amplitude-modulated by 20,000-cycle A.F., a note inaudible to humans

Any radio-telephone transmitter consists of an R.F. generator and amplifier and an audio amplifier. The audio amplifier builds up the signal from a microphone until it is capable of modulating the R.F. output, so that the final radio wave varies in intensity according to the variations in sound that reached the microphone. This is standard amplitude modulation, or A.M. transmission.

In the transmitter shown, the A.F. system consists of the 6SJ7, one half of the 6SN7, which is a dual triode, and the 6L6 power tube. The R.F. section consists of the other half of the 6SN7, which serves as the R.F. generator, and the 6V6 power amplifier.

For coil L4, pick the biggest choke coil you have—the one with the largest iron core. It should be designed for no less than a 90-milliamp. load; a 15-henry, 120-milliamp. choke is much better.

This choke coil causes modulation of the R.F. output. Like any other large inductance, it tends to maintain the flow of current through it at an even level. Both the 6L6 A.F. amplifier and the 6V6 R.F. amplifier are drawing their plate current through it. With no audio signal, the 6L6 draws about 50 milliamp. and the 6V6 about 30 milliamp. —a total of 80 milliamp. flowing in the choke coil. But if an audio signal suddenly causes the 6L6 to draw 80 milliamp. instead of 50, the 6L6 will draw all of it and the 6V6 will be starved, since the choke resists any abrupt increase in the total current flowing. As there is no current for the 6V6 plate, the R.F. signal strength will fall to zero. When the A.F. signal swings to negative, it blocks the 6L6 so that this tube abruptly draws no current. Now precisely the opposite thing occurs. The self-inductance of the choke maintains the full 80-milliamp. current through it, and all this current is applied to the 6V6 so that the R.F. output skyrockets accordingly.

The A.F. amplifier is a simple two-stage setup feeding a single power output tube. With a 3" permanent-magnet speaker as a microphone coupled through a 20,000-ohm output transformer, full modulation is obtained from normal conversation 20' away.

To prevent pickup of 60-cycle hum by this transformer, it is best to put it with the speaker in a separate case, and to use a shielded microphone cable at least 4' long to connect it to the transmitter.

The oscillator coil for the R.F. circuit of the 6SN7 is a standard 2.5-millihenry R.F. choke with four coil sections or pies. Ground one end and tap the lead between the first and second pies from this end for the cathode connection. With reasonable care

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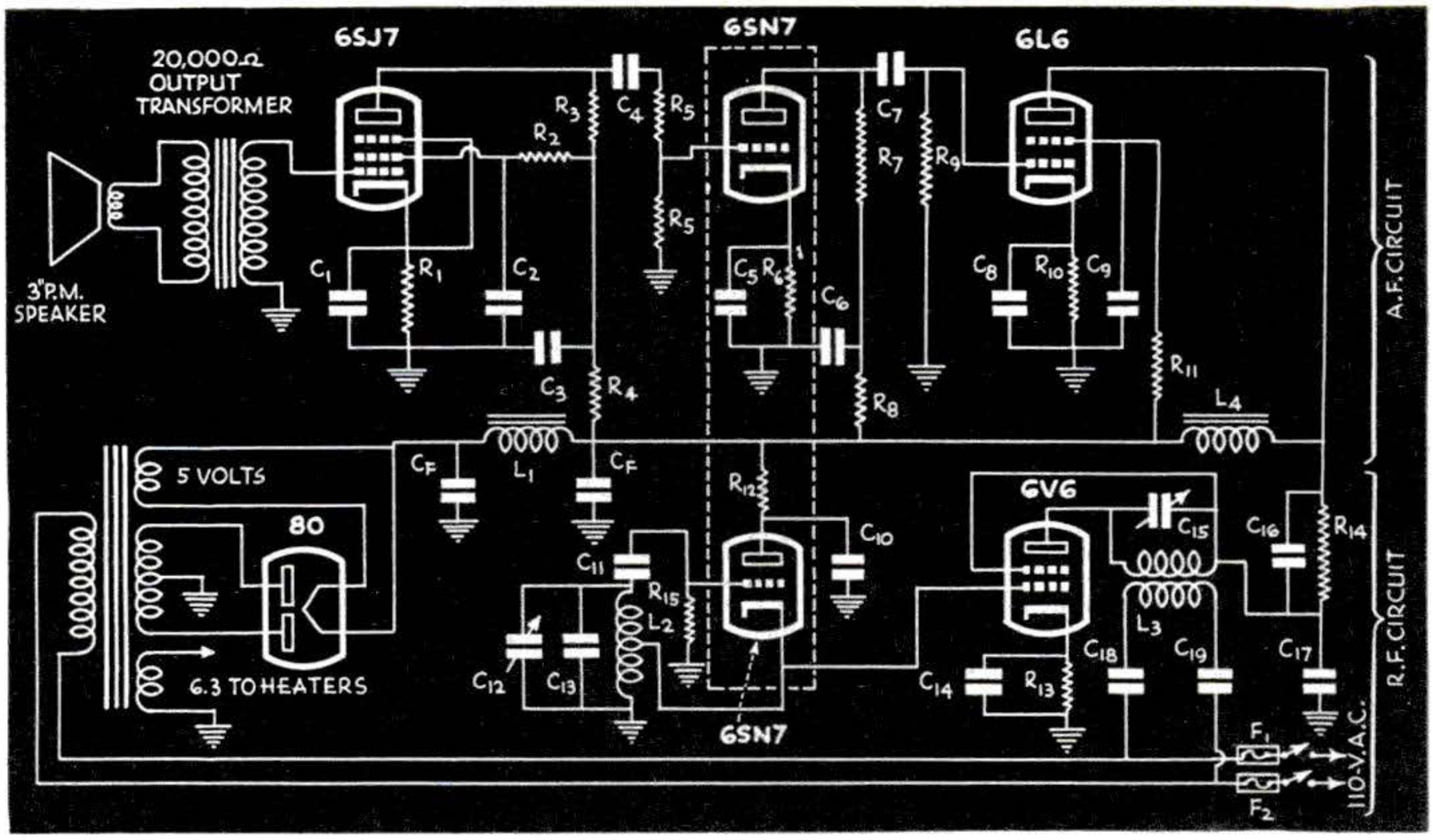

In this circuit a 6SN7 dual triode does double duty, but two separate triodes may be used in the same way

you can lift the wire by using a sharply pointed pencil. Seal it back with a drop of paraffin when the connection has been made. A 500 to 800-mmfd. trimmer condenser is used to tune the coil to match the receiver; if necessary, a 200-mmfd. fixed mica condenser is added in shunt.

The plate tank coil is homemade. It consists of 100 turns of No. 22 enameled wire close-wound on a standard 1½" form or a 1½" cardboard tube saturated with paraffin. The secondary coil is six turns of No. 18 wire wound over a layer of insulating cambric or wax-soaked wrapping paper around the center of the primary.

Once the transmitter is connected to the power line, strict caution is in order. You are not working with the R.F. voltage common to receivers, but with about 600 volts of R.F. energy. It bites. It has a tendency to reach and painfully nip unwary knuckles, carrying 300 volts of D.C. along with it. *Hands off!* is the only safe rule so long as the chassis is operated outside its cabinet.

A neon bulb held close to the tank coil will light up readily by reason of radiated R.F. energy. Similarly, enough voltage can be induced in even a 1" length of wire to cause feedback and start unwanted oscillation. Therefore, put a single ground lug near each tube socket and make all ground connections relating to that tube to that one lug.

If the builder wants to use the outfit from his house to a certain other one, it may pay him to first investigate the power hookup between them, as results from any carrier-current communicator may be somewhat unpredictable. For example, it may work well to a house three blocks away and not at all to another across the street. One reason for such irregular operation may be that the nearer house derives its electricity from another distribution transformer.

(To be concluded)

LIST OF TRANSMITTER PARTS

C_1, C_5, C_8: 10 mfd., 25 volts electrolytic
C_2, C_3, C_6, C_9, C_{10}: 1 mfd., 400 volts
C_4, C_7: .005 mfd., 400 volts
C_{11}: 100 mmfd. mica
C_{12}: 500 mmfd. trimmer
C_{13}: 200 mmfd. mica
C_{14}: .25 mfd.
C_{15}: 3000 mmfd. variable
C_{16}: 1 mfd. paper, 400 volts
C_{17}: .01 mfd., 400 volts mica
C_{18}, C_{19}: .1 mfd., 600 volts.
F_1, F_2: 3-amp., 250-volt fuses
R_1: 2,000 ohms
R_2: 1 megohm
R_3: 250,000 ohms
R_4, R_9: 100,000 ohms
R_5 (two): 250,000 ohms each
R_6: 1,000 ohms
R_7, R_{15}: 50,000 ohms
R_8: 20,000 ohms
R_{10}: 250 ohms
R_{11}: 40,000 ohms
R_{12}: 10,000 ohms
R_{13}: 300 ohms
R_{14}: 10,000 ohms, 10 watts, wire wound
L_1: 10 henries, 100 milliamp.
L_2: 2.5-millihenry R.F. choke, tapped
L_3: primary, 100 turns No. 22 enamel-covered wire close-wound on 1½" form; secondary, 6 turns No. 18 enamel-covered wire wound over middle of primary.
L_4: 120-milliamp., 15-henry power filter choke

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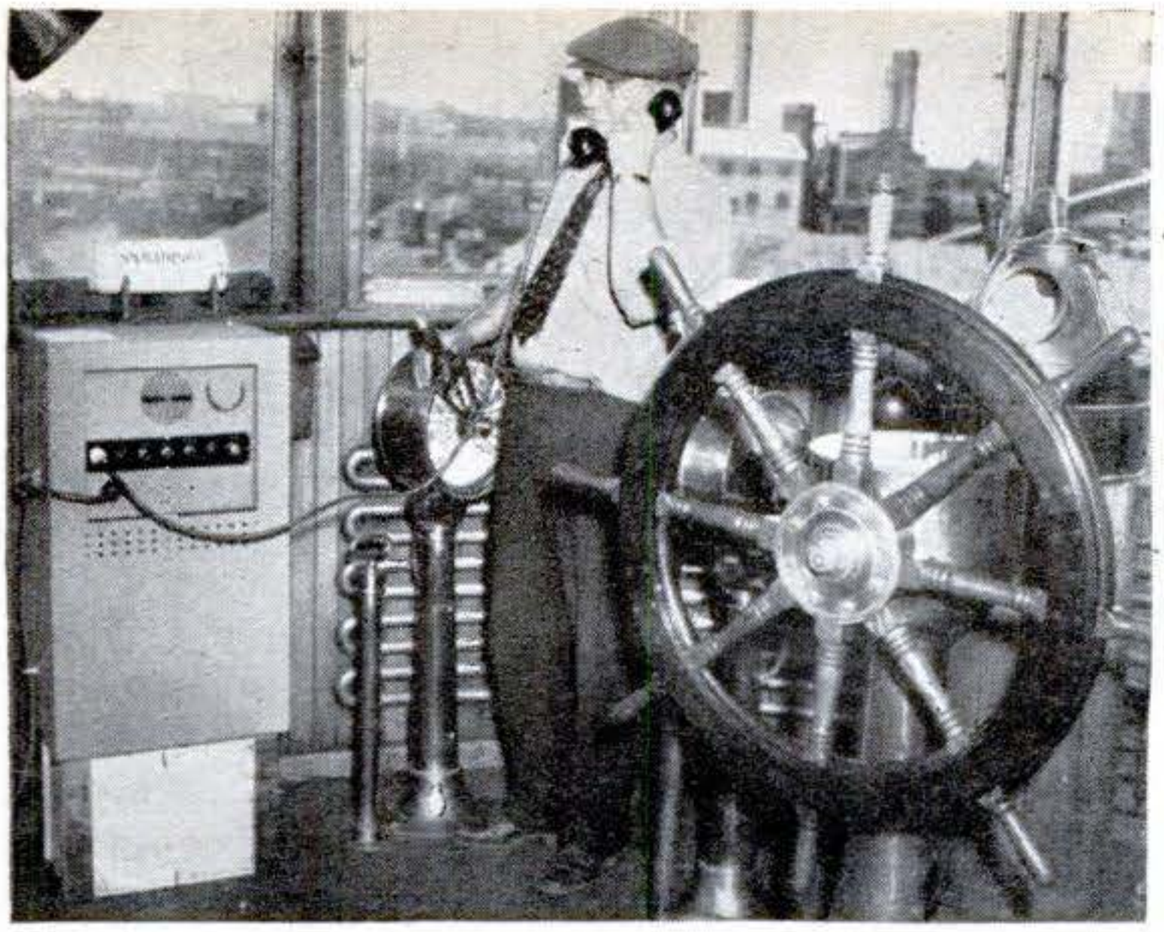
radio ideas

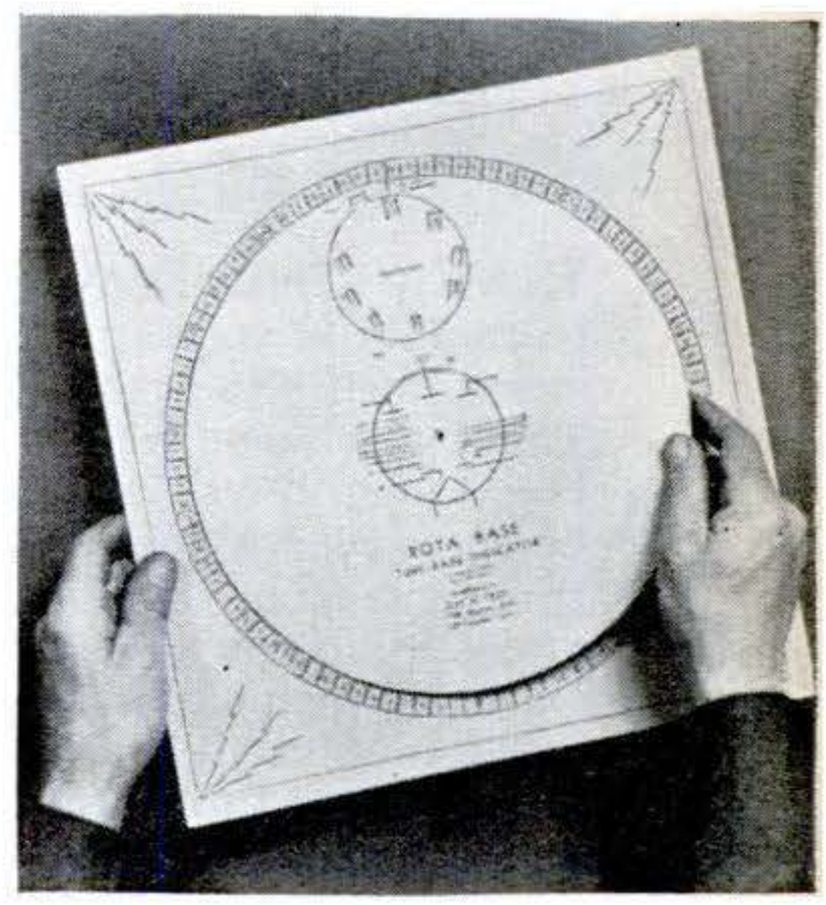


SHIP-TO-SHORE F.M. RADIO has been given extensive tests on the Great Lakes, six transmitter-receiver units being put in operation on car ferries, fishing tugs, and cargo vessels for a period of 90 days. The entire equipment, with the exception of the power source, is contained in a single cabinet, one of which is shown at the left in the photo. All that is necessary to get in touch with a shore station to report information or to receive instructions is to lift the telephone-like receiver and to call the station signal.

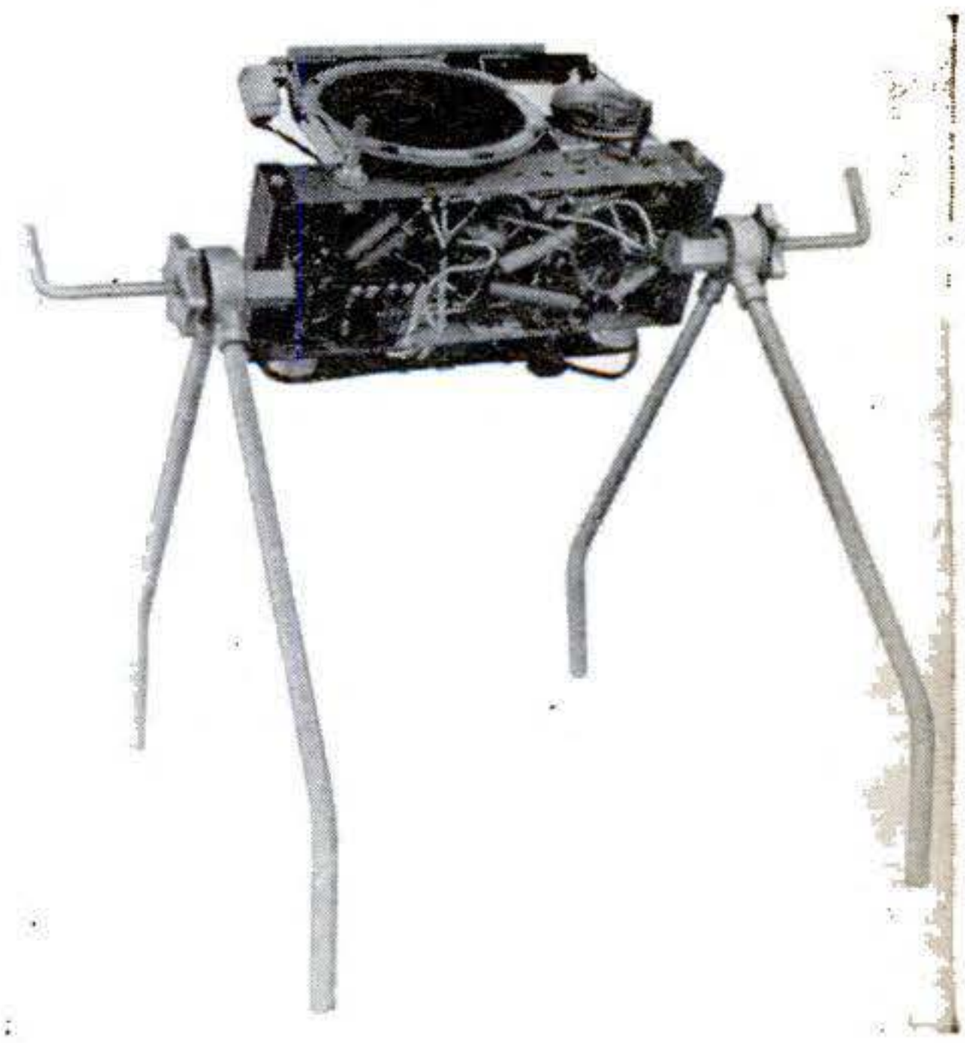
The tests were conducted by the Lorain County Radio Corporation, of Port Washington, Wis., and engineers of the General Electric Company. An F. M. transmitter-receiver is shown in use by Acting Captain Walter Dummer aboard the Great Lakes car ferry Madison.

PORTABLE-RADIO "MIKES" designed for police and airport communication and public-address systems have been put on the market by the Electro-Voice Corp., of South Bend, Ind. They are ruggedly built for use in temperatures ranging from 185 deg. to 40 deg. below zero.

TUBE-BASE CONNECTIONS for more than 300 tubes are readily found on the dial selector shown at right. A turn of the dial to put the arrow opposite the desired tube type in the outer circle shows filament, grid, plate, and cathode connections and other information in the openings, along with the number of each connection on octal sockets.



ASSEMBLY, INSPECTION, AND REPAIR are faciliated by a new chassis cradle that permits locking of a radio receiver in any position. Both hands of the serviceman are thus left free for the job without danger of dropping or bumping the receiver. The cradle, set on legs, is made of cadmium-plated steel and white metal by the Acro Tool & Dye Works, of Chicago.



PHOTOELECTRONS FROM THE MOON are believed to affect radio reception as a result of data obtained from 20,000 hours of observation over two periods of four years each. According to a report to a General Electric Science Forum by Dr. Harlan True Stetson, of Massachusetts Institute of Technology, radio reception was best from the first quarter to the full moon and also from the last quarter until shortly before the new moon. Observations made in the dark of the moon—that is, when no radiations reflected from the moon could reach radio waves on the path under study—showed no such variations in the quality of reception.

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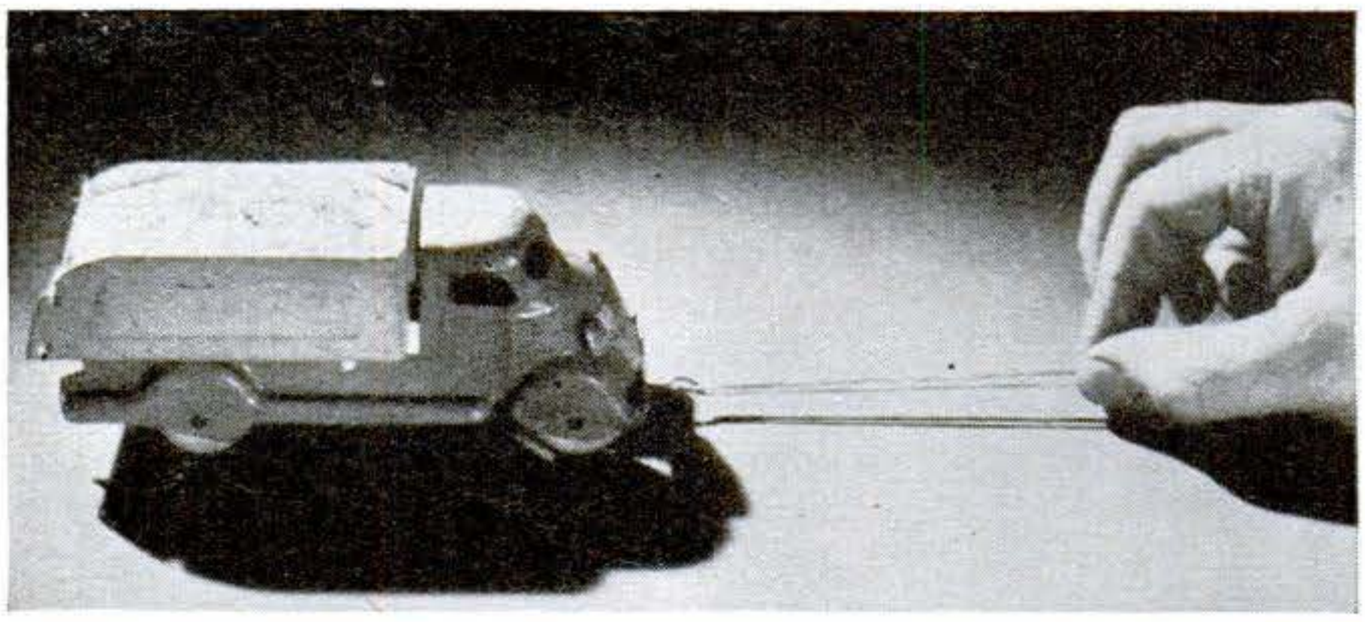
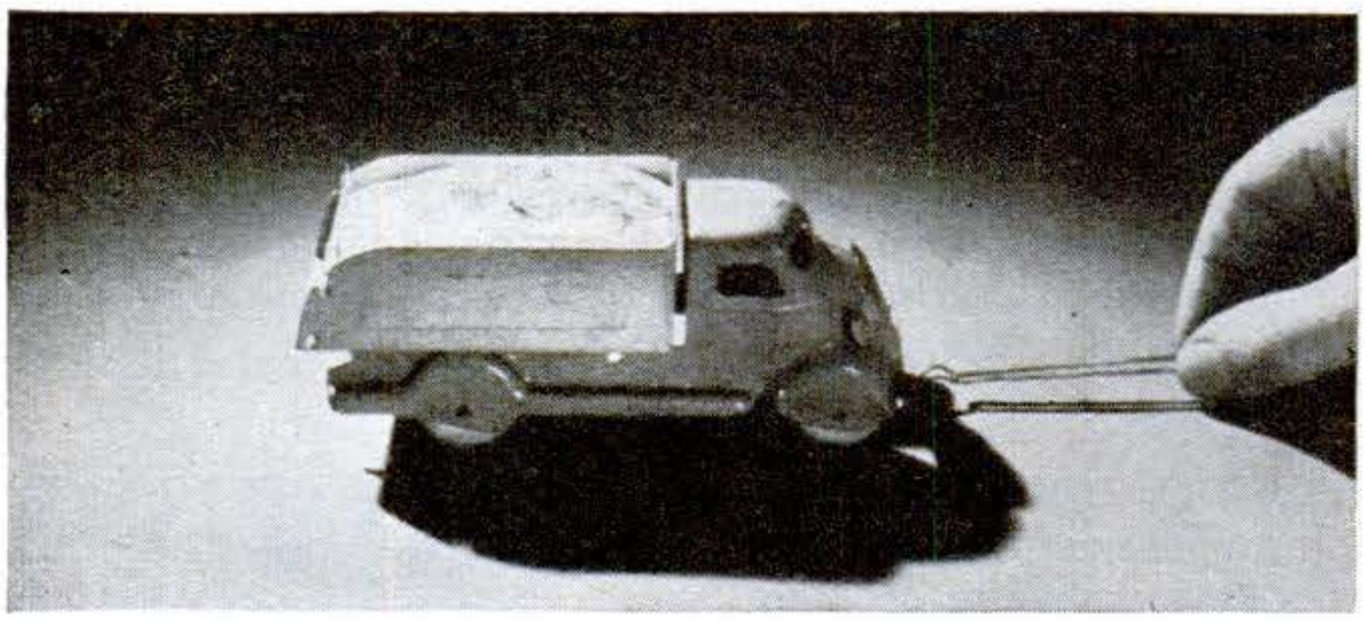
HOME EXPERIMENTS



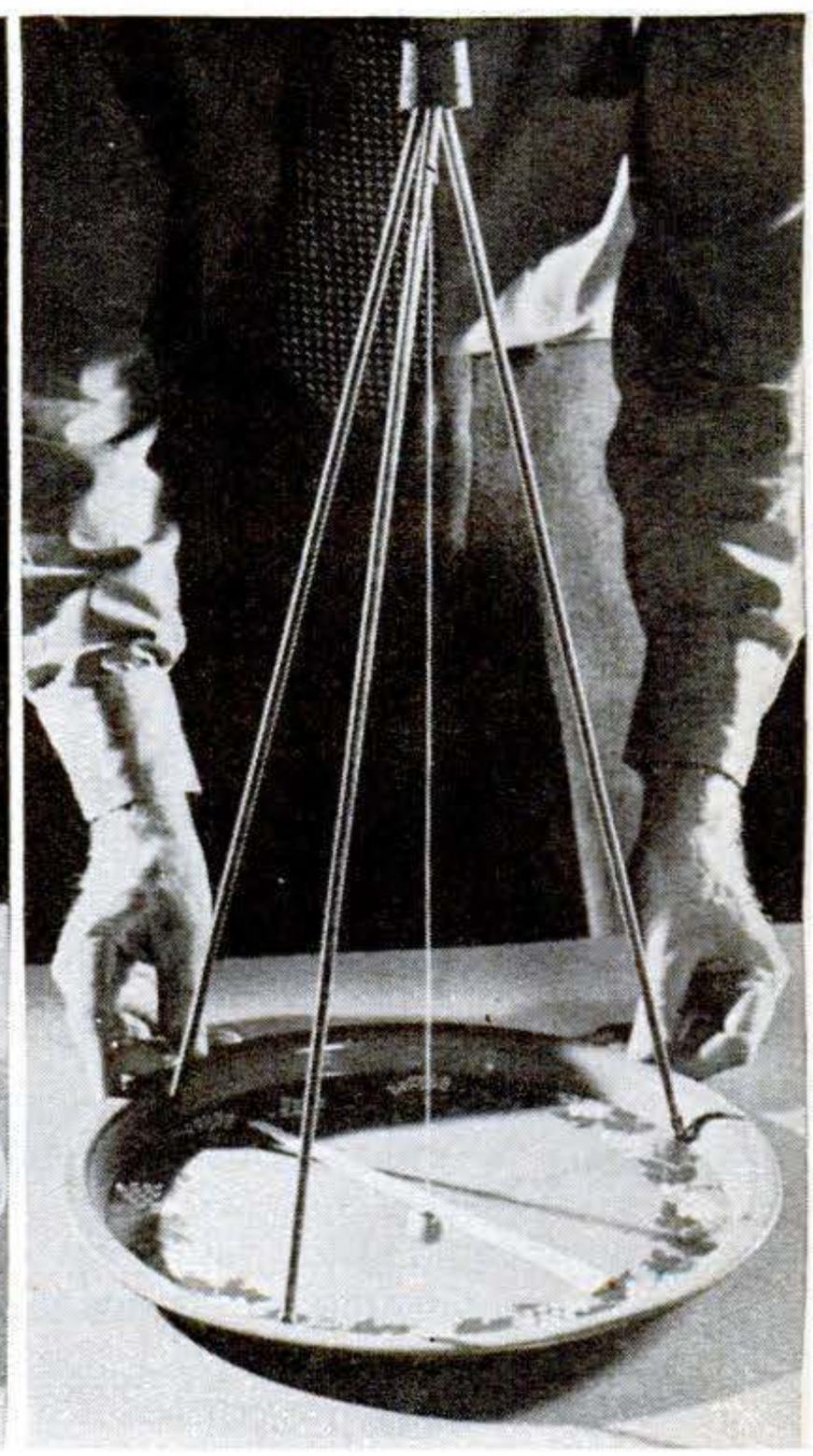


WHY MORE POWER is needed to start your car than to keep it going at moderate speed may be shown by pulling a loaded toy truck by means of a rubber band. The rubber stretches far less once the toy truck is in motion than it does when you attempt to get it started. This is because inertia and static friction both act to resist motion when the truck, or your car, is standing still. Considerable force is required to overcome friction of parts not moving in relation to each other (see P.S.M., Jan. '45, p. 203). Inertia, which causes an object to resist changes in speed, calls for application of force to attain a desired speed. Because of inertia, force must also be applied, as by brakes, to stop in a short distance a car already in motion.

THAT A PENDULUM swinging freely tends to remain in the same plane can be demonstrated with the simple setup shown here. This experiment was first made famous by the French physicist Foucault in 1851 when he suspended a heavy copper ball by a long, thin wire from the dome of the Pantheon at Paris. Once the pendulum was set in motion, its oscillations seemed to rotate in clockwise fashion in relation to the floor of the building. Foucault demonstrated mathematically, however, that what was really being observed was the rotation of the earth beneath the pendulum.

At the North and South Poles the pendulum would seem to reverse itself completely every 24 hours, while at latitudes between them the turning would be correspondingly less. Only at the equator would the pendulum swing without seeming to rotate.

With a marble suspended from a tripod by a thread, the demonstration can be given in miniature. Start the marble swinging over a path marked on a tray. Then, to represent the rotation of the earth on its axis, turn the tray slowly, and the relation of swing to the marked path changes. The plane of the swing remains constant.



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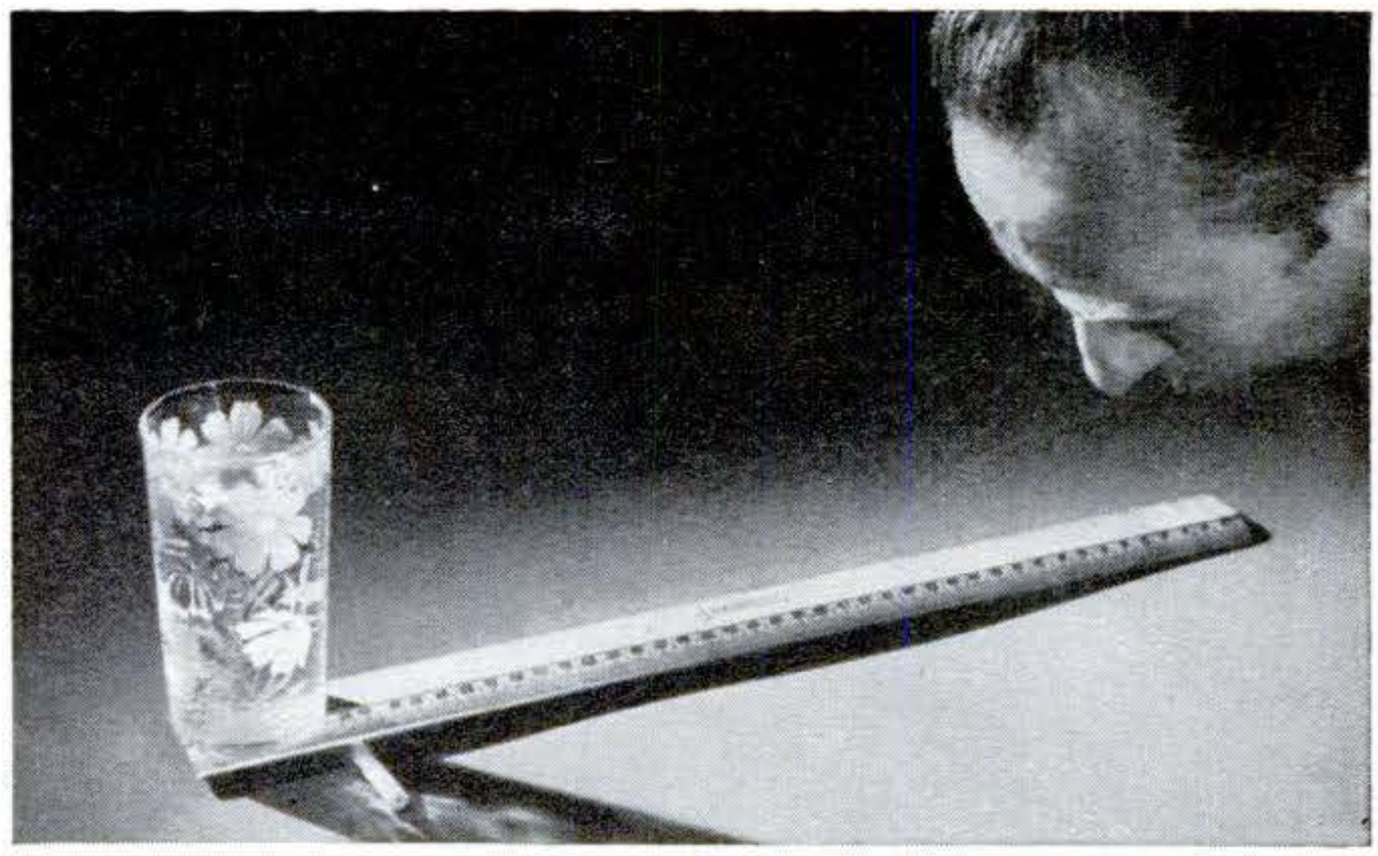
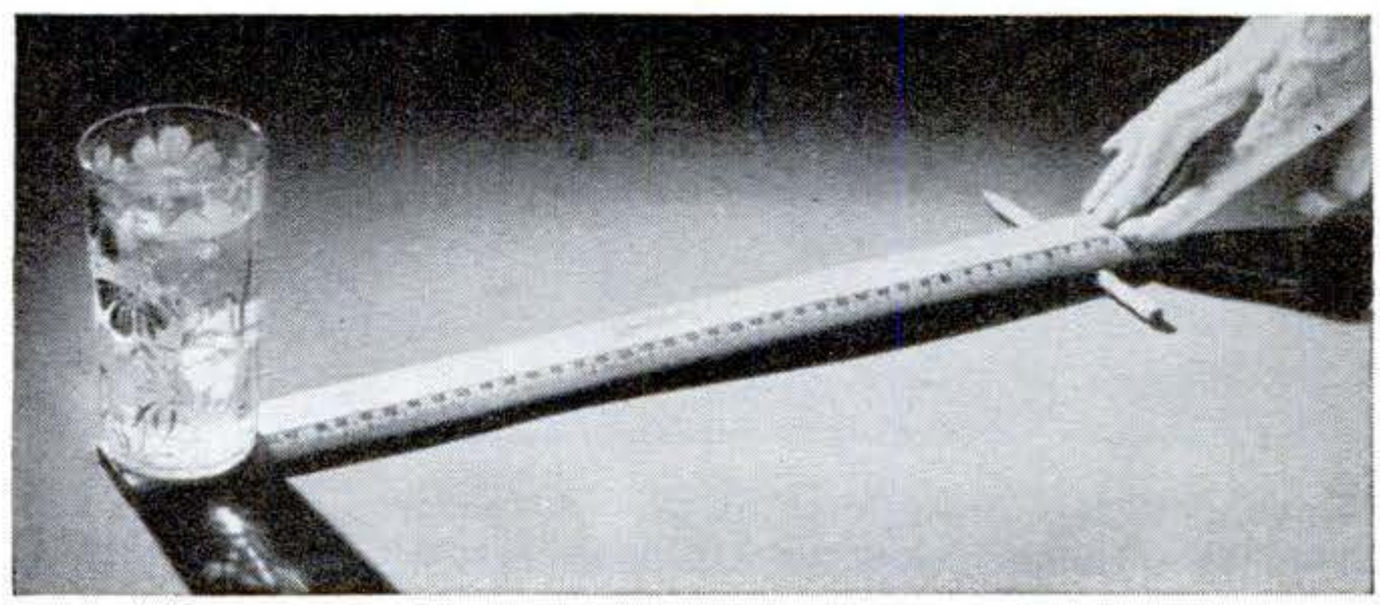
SHOW LAWS OF MECHANICS——

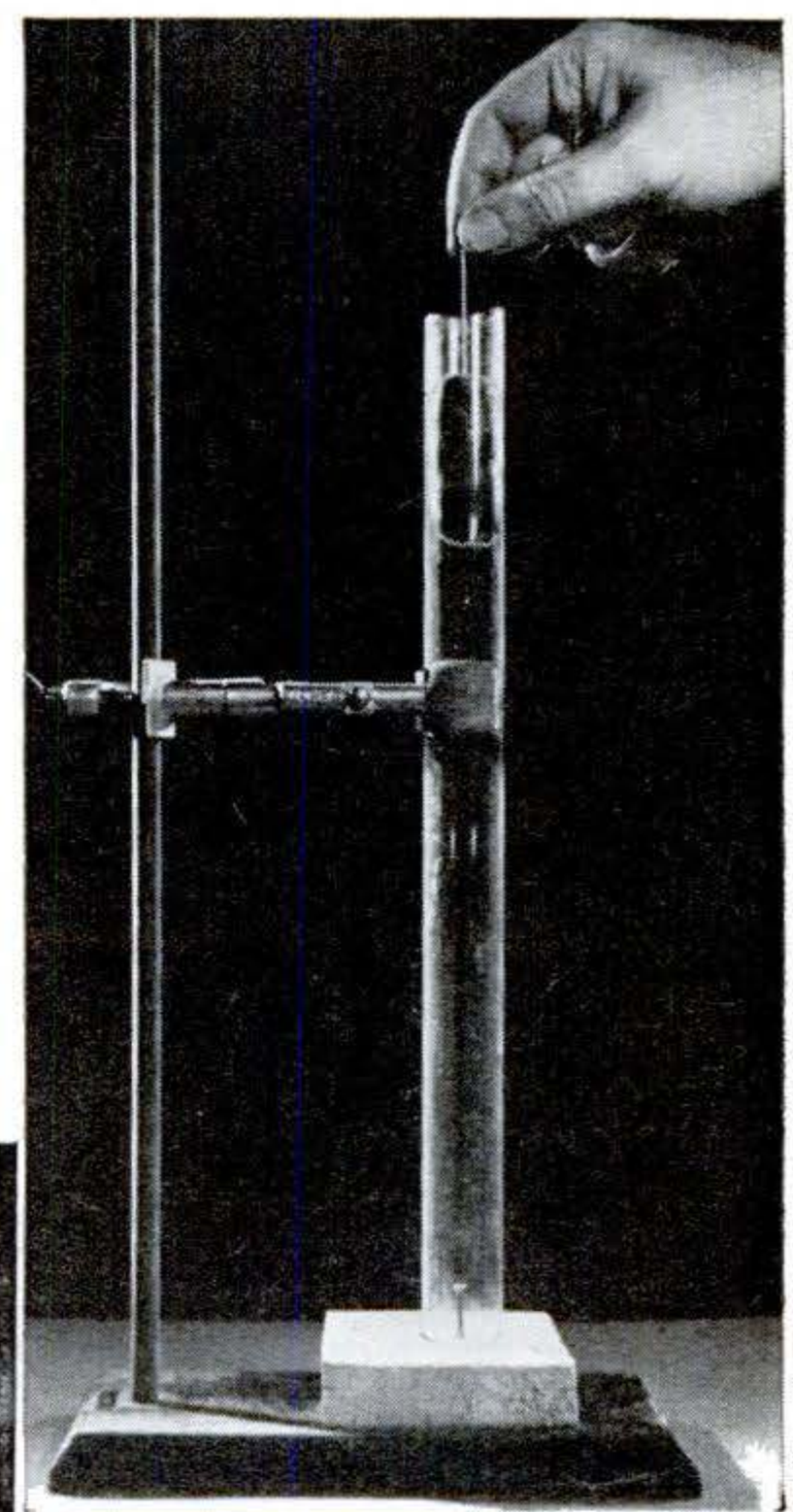
SIMPLE LEVERS assist in the performance of many tasks. In everyday life the can opener, the oar, the shovel, the scissors, the crowbar, and the human arm are examples of devices using the lever principle. An effort exerted at some point on a lever having a fulcrum has an effect on a resistance at some other point. If the distance between fulcrum and effort is greater than that between fulcrum and resistance, we gain the mechanical advantage of force; in the reverse, we get speed or distance of travel.

Make a simple lever of an 18″ ruler resting on a pencil for a fulcrum, and set a glass of water on one end. With the fulcrum near the glass, you can raise the weight simply by blowing on the far end. Put the fulcrum 1″ from the far end, though, and you won't be able to budge it.

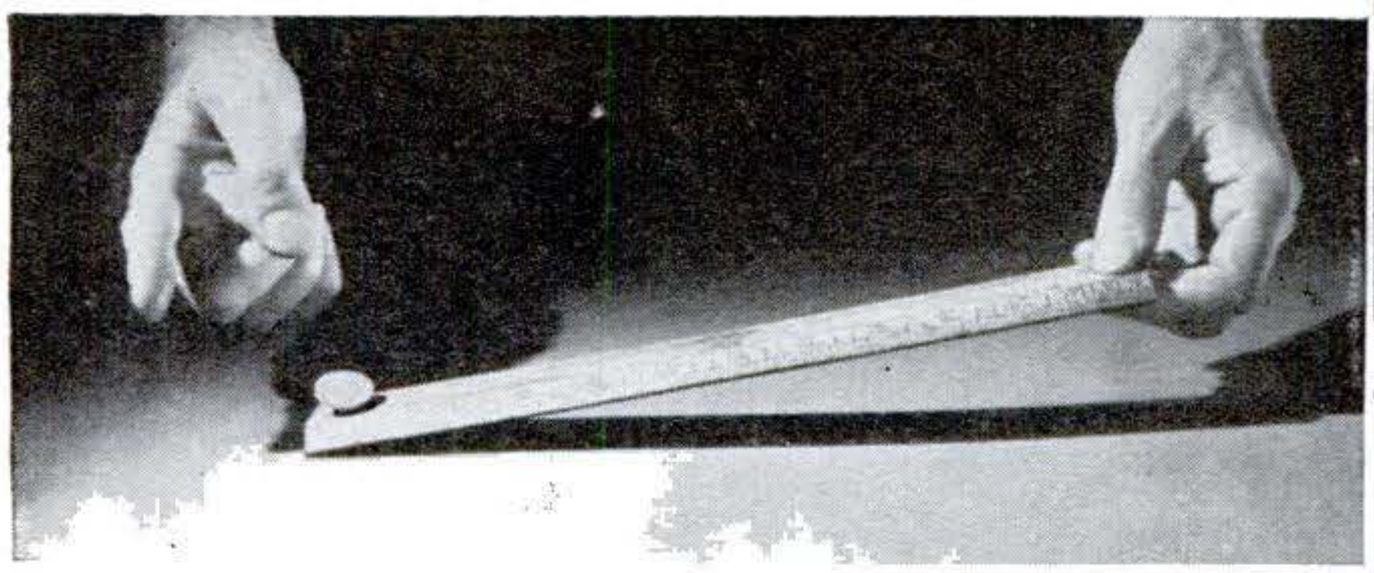




POTENTIAL ENERGY is given to an object merely by lifting it, and in the pile driver this energy is harnessed to do useful work. Make a miniature pile driver from a 12″ or 18″ glass tube or ordinary mailing tube and an iron or lead weight fitting in it loosely and held by a string. Center your pile driver over a small flathead nail barely started in a piece of soft wood. You can drive the nail in by repeatedly dropping the weight. This energy is measured in foot-pounds, the product of the weight multiplied by the height.



WHICH FALLS FASTER, a ruler or a coin placed at one end? If you drop the ruler altogether, both fall with the same speed. But if you hold onto one end of the ruler, the end you release drops faster than the coin—you can hear the *click* as the coin hits last. Thus held, the ruler becomes a pendulum, and its center of percussion (two-thirds down from its supported end) falls at the acceleration of gravity as does the coin. The free end of the ruler actually falls faster.



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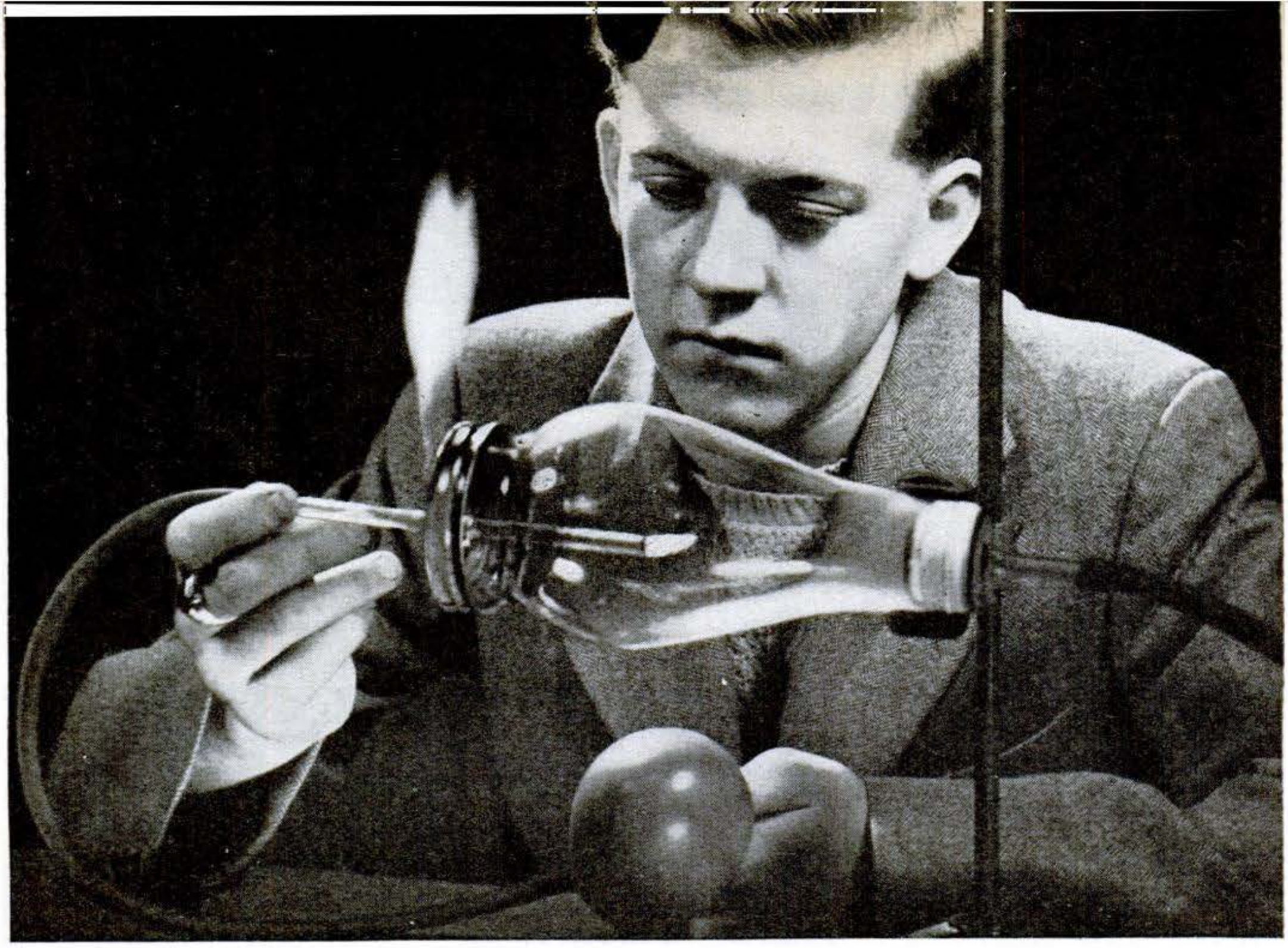

Illuminating gas, issuing from the chimney, burns in air, while inside the chimney, air passing from the balloon through the glass tube burns in gas. It is ignited when the tube is pushed through the flame

The Chemistry of Fire

WHEN MAN LEARNED HOW TO CONTROL COMBUSTION, HE WON WHAT BECAME THE ALADDIN'S LAMP OF CIVILIZATION

By Kenneth M. Swezey

IF YOU call the genie of Aladdin's lamp *fire*, or *combustion*, you have something much more remarkable than a mere fairy tale. Fire, intelligently controlled, is certainly the chief wonder-working servant of civilization. Look into many of the essentials of modern life—such as heat, food processing, manufacture, chemical synthesis, and steam and gasoline transportation—and you will find fire to be the magic source of all these wonders.

So universal is the knowledge and use of fire that no one knows when or how it was discovered. Thousands of years ago it was considered one of the four elemental building blocks making up the world. As late as the eighteenth century, the phlogiston theory defined fire as a material in combustible substances that left them when they burned.

It was not until the 1770's that the real secret of combustion was learned. The French scientist Lavoisier, discarding the speculations of his predecessors, buckled down to careful experimentation. By precise weighing and measuring of all the products that resulted from combustion, he discovered that they weighed more, not less, than the substance burned. Then fire, or combustion, he reasoned, was not the result of a sundering of substances but a union of them. In all cases he tried, Lavoisier found one of the substances present was a gas, recently discovered by Priestley, which Lavoisier named oxygen.

Today we say that combustion is the effect produced by the violent union of two or more chemical substances generally accompanied by light and heat. Usually one of the substances is oxygen, but now it is recognized that oxygen need not always be present—other substances may combine to produce an effect that must be included under the present definition of fire.

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Sulphur and iron, for instance, produce light and heat when they combine, and they do so without the help of oxygen. Mix equal parts of powdered sulphur and iron filings, and put 1″ of the mixture in a hard-glass test tube. Heat the bottom of the tube strongly over a Bunsen burner, and presently the whole mass will glow, the glow continuing even after the heat is removed. The result of the combination is iron sulphide, a chemical which may be of use to you in future home experiments.

Fire, or combustion, as we ordinarily recognize it, is the result of the rapid combination of oxygen with a combustible substance. Although we usually think of the combustible solid, liquid, or gas as being burned, oxygen plays an equal part. To prove this, you can perform a simple experiment in which air, or oxygen, can be made to burn in an atmosphere of illuminating gas—reversing the customary method of burning gas in air.

Mount horizontally a lamp chimney, or a bottle with its bottom cut off. Then connect a glass tube through a one-hole stopper to a rubber tube leading to a supply of illuminating gas, and insert the stopper in the small end of the chimney. Hang loosely over the other end a jar cover having a ¾″ hole in its center. Fit a 10″ glass tube to 12″ or so of rubber tubing which is connected to a toy balloon with a pinch clamp to cause air to flow through it slowly.

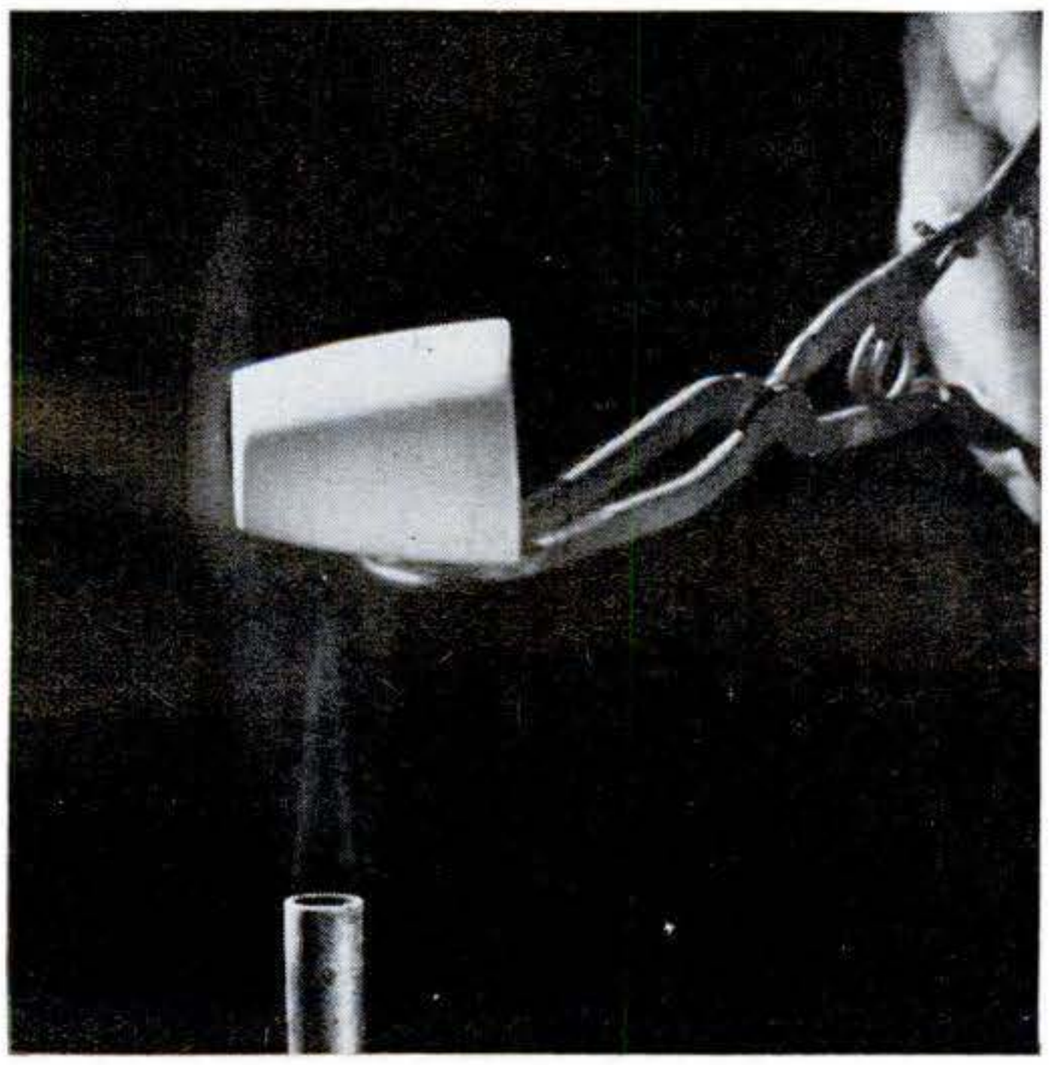
Turn on the gas and, *after allowing 10 or 15 seconds* for it to flush the air from the chimney, ignite the gas issuing from the hole in the jar cover. Reduce the flow to get a flame 2″ or 3″ long. Now introduce the glass tube, air flowing through it gently, into the chimney. The air must flow slowly and steadily for best results. As the tube passes the lighted gas on the outside of the chimney, the air coming through it will ignite, and this flame can be carried far into the chimney. It is an example of reciprocal combustion—air burning in combustible gas.

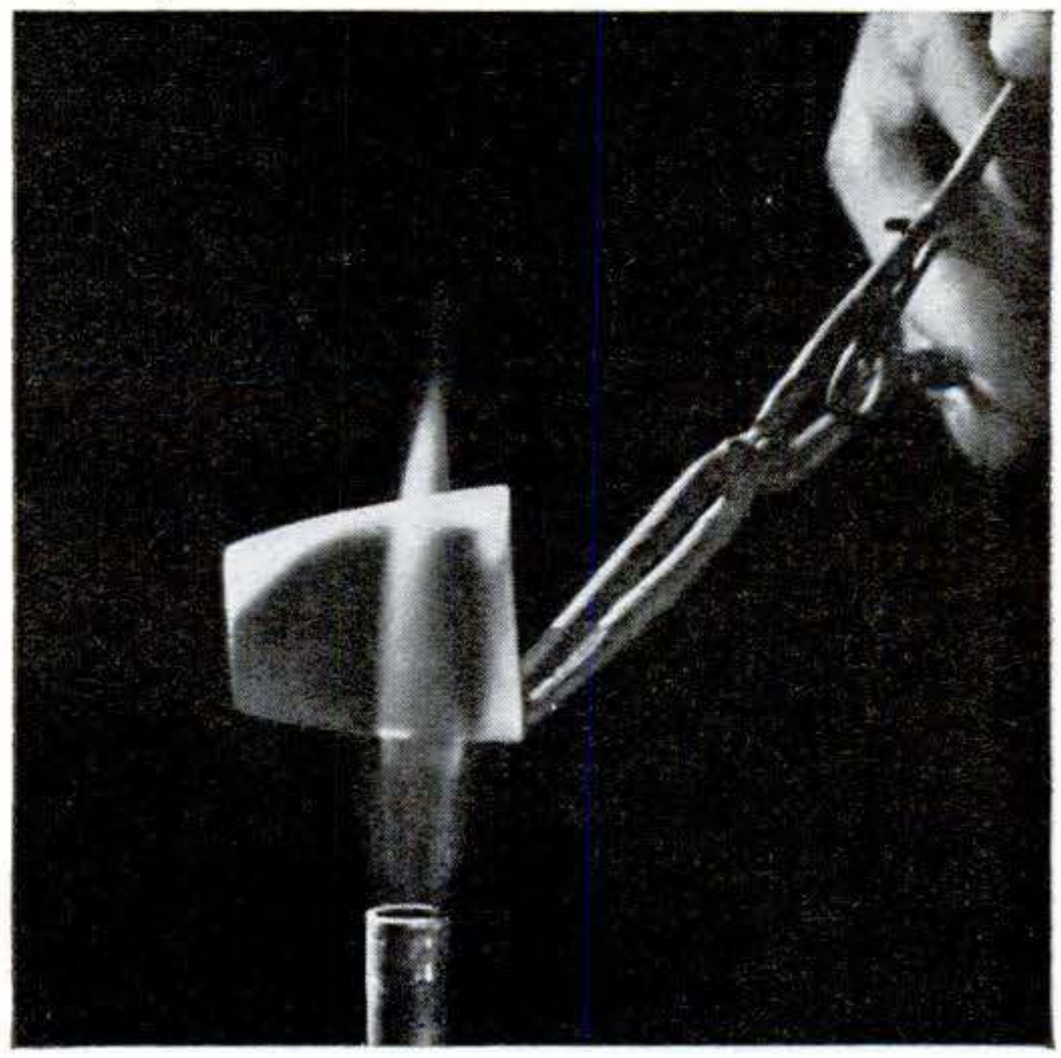
Illuminating gas, fuel oils, and candles are composed chiefly of complex mixtures of carbon and hydrogen, and during combustion they are decomposed. If sufficient air cannot enter into the reaction, solid particles of incompletely burned carbon are released. The glow of these particles produces the opaque yellow flame of candles, old-fashioned gas jets, and Bunsen and gas-range burners in which the air supply has been reduced.

When gas jets were a source of light, luminous flames were practical. In modern heating systems, however, they are sometimes the result of inefficient adjustment, and they mean soot and wasted fuel. You can show this with your Bunsen burner and a cold porcelain crucible or some other cold object. Cut off the air supply of the burner, and the yellow flame will smoke up the crucible in a few seconds. But if the burner is properly adjusted to admit sufficient air, the flame will not only not smoke up the porcelain, but it will actually burn off accumulated soot and leave the crucible clean and white.

An interesting stunt will demonstrate the comparative coolness of a candle flame. Scrape off the insulation of some bell wire and make a little copper coil by winding 10 or 12 turns around a pencil. Lower this coil over a candle flame, and the flame will go

Held in a flame that is getting sufficient air for complete combustion, a cold porcelain crucible will not smoke up, but in a flame not getting enough air, it collects black, sooty carbon, as shown at right. Readjust the burner to give the flame air, and it will quickly consume all the carbon on the crucible





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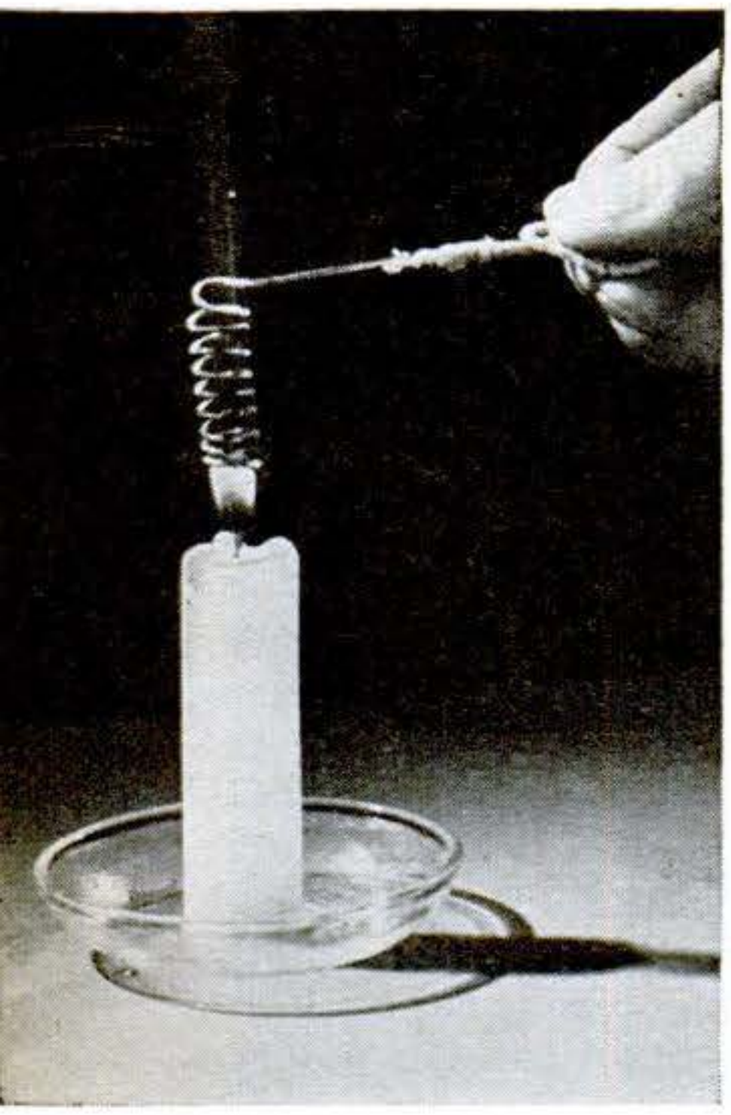


Candle flames are comparatively cool and can be extinguished simply by taking heat away faster than it is generated, as shown at left where a copper coil is used. At right, carbon disulphide bursts into flame as a heated rod is brought near

out to the depth you lower the coil, heat being taken away faster than it can be generated.

Fortunately, oxidation violent enough to be called combustion does not occur to most substances until they have first been subjected to considerable heat. The temperature required depends upon the substance, the state in which it is divided, and the possible presence of catalysts that might aid oxidation. A few substances like lime (calcium oxide) and asbestos (a fibrous silicate mineral) do not burn in the true sense no matter how high the temperature. Simple oxides and certain other compounds already contain their maximum amount of oxygen.

The temperature needed to start combustion is the "kindling point." Substances with low kindling points are fire hazards and should be handled intelligently. Yellow phosphorus, for instance, ignites spontaneously in air at room temperature, and when not in use it must be kept under water.

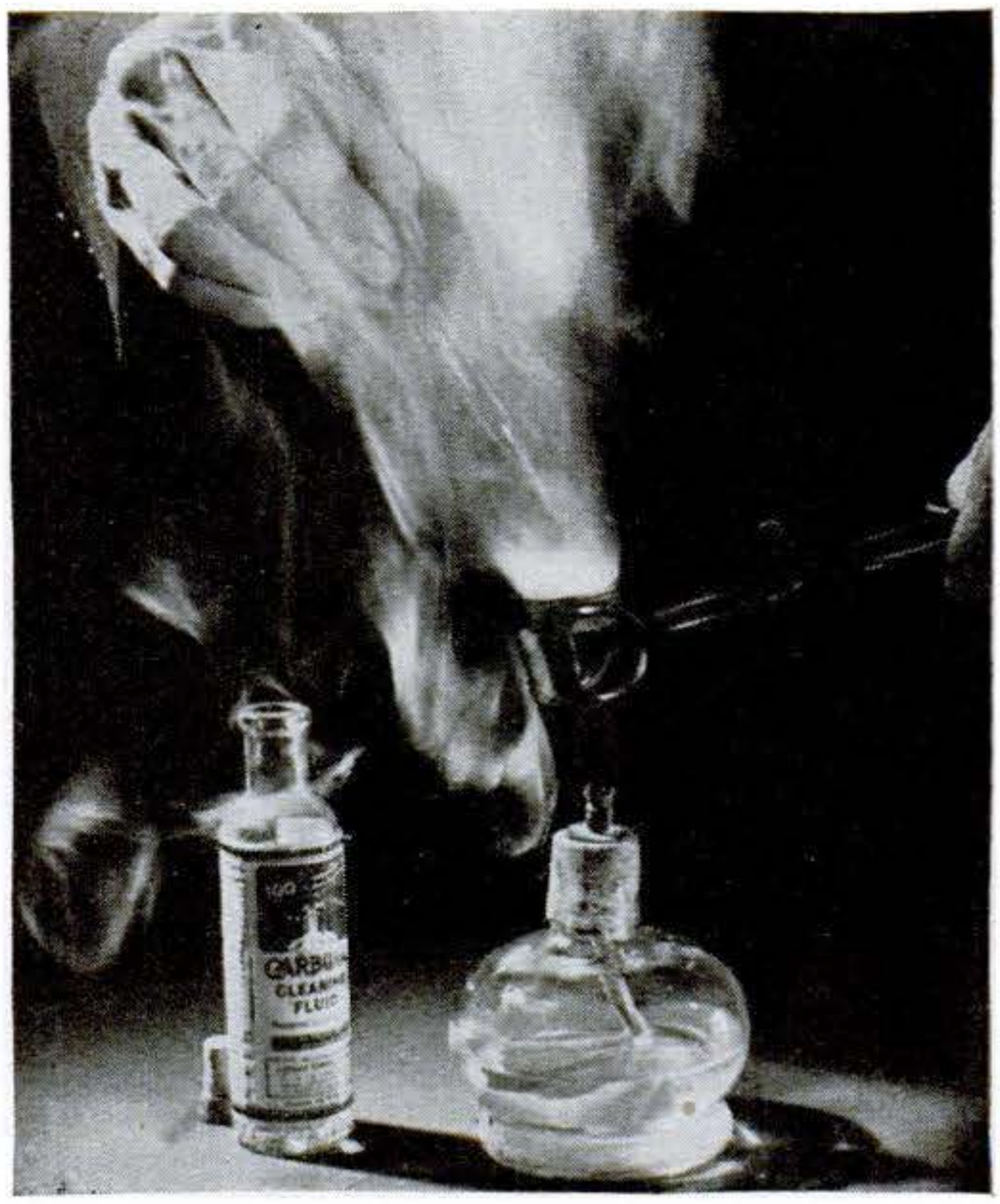
Many volatile liquids may catch fire without actual contact with flame—a few without contact with any visible source of heat. If you use caution, you may demonstrate this without danger. Pour a very small amount of carbon disulphide on a little cotton wad in a jar cover, taking the precaution to *keep at least 20′ from any open flame while handling this highly inflammable liquid.* If possible, perform the experiment in the open air or on an unenclosed porch. Heat an iron curtain rod or a heavy iron wire red hot in a Bunsen flame, remove it, let it cool until the redness just disappears, and then quickly hold the rod close to the top of the soaked cotton. The carbon disulphide will burst into flame.

Exercising the same caution, repeat the experiment with such liquids as ether, benzine, and alcohol. The temperatures at which they ignite can be compared by the redness of the rod. And one important lesson will be learned: *Many common solvents are highly inflammable and should always be handled with care!*

Some substances not ordinarily combustible may be made to burn by uniting them in certain combinations and under certain conditions. Sand and carbon tetrachloride are used for extinguishing flames, and a piece of zinc is nothing with which to kindle a fire. But mix equal parts of fine sand and zinc dust, put a little in a metal bottle cap, heat it over a small flame, and add a few drops of carbon tetrachloride. You will get fire and clouds of smoke. The combination is a smoke-producing agent in warfare.

What happens is a complex reaction. The heated zinc combines with the carbon tetrachloride to form zinc chloride and particles of carbon. Vaporized by the heat, the zinc chloride then reacts with the moisture in

Sand, zinc dust, and carbon tetrachloride do not ordinarily burn, but mix them properly and they give off a dense smoke like that used in warfare



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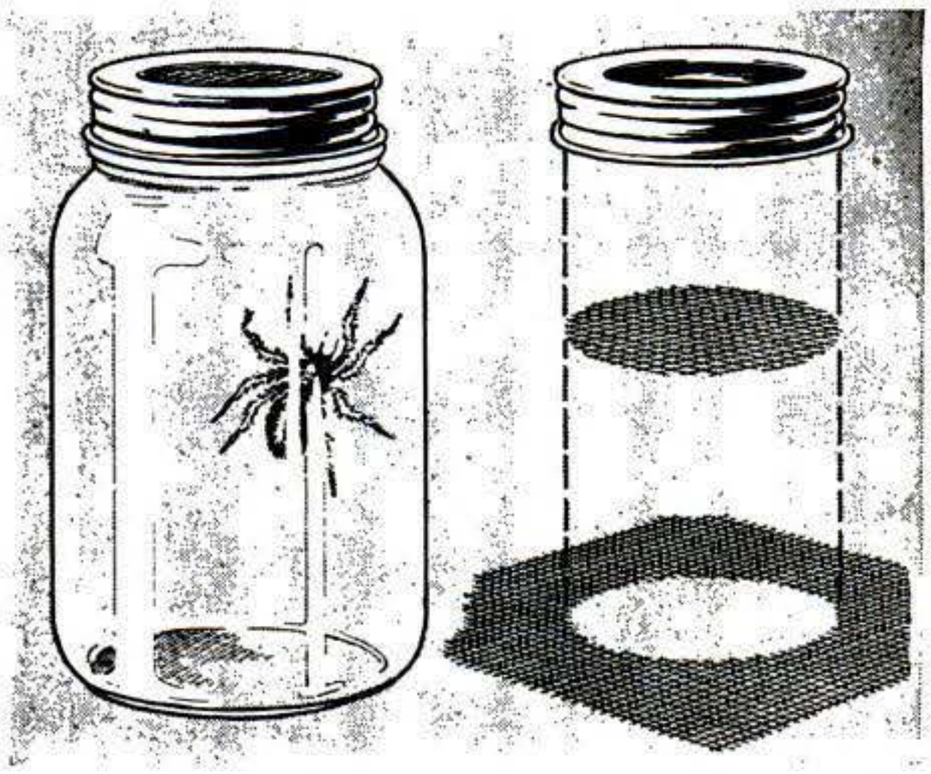
the air to form white zinc oxide, and this, mixed with the particles of black carbon, makes the dense gray smoke.

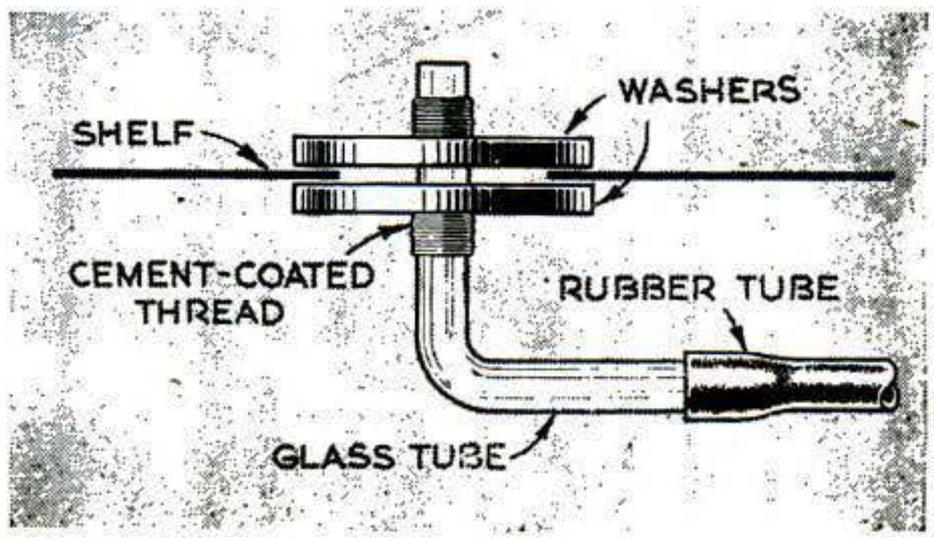
Occasionally substances packed with oxygen react so strongly with certain other substances that they generate internally enough heat to produce combustion. Powder several grams of potassium permanganate and place in a jar top on an asbestos pad. Make a little depression in the center of the powder, add just three or four drops of glycerin, and *stand back at once.* The mixture will sputter and soon burst into a dazzling white flame, as at the right, giving off volumes of smoke.

BOTTLED CLOUDS are used in the Westinghouse Research Laboratories for testing insulating materials to go into new bombers. Made from liquid air and warm water by Arthur M. Stiles, research engineer, these artificial clouds are introduced into sealed flasks in which the materials are then tested for resistance to dampness occurring under various atmospheric conditions. Besides simulating actual clouds, the air-water combination in these flasks, or "altitude chambers," can be made to present many other forms of natural precipitation. When a flask is cooled below the freezing point, tiny snowflakes collect on the materials as they would in a snowstorm.

LIVE INSECTS can be kept in a Mason jar of the type having a two-piece cover if it is fitted as shown below. Replace the flat disk in the cover with a circular section of screening, cut to fit snugly in the ring.—KENNETH MIDDLEHAM.



GLASS TUBING can be attached to the shelf in a pneumatic trough by a simple, nonslip method. Two washers having an inside diameter just large enough to take the tubing are used, one above the shelf and one below it. The hole in the shelf is smaller than the outside diameter of the washers. Slip the tubing through the washers and seize it with thread as shown. Then coat the seizing with cement.—RALPH REHM.



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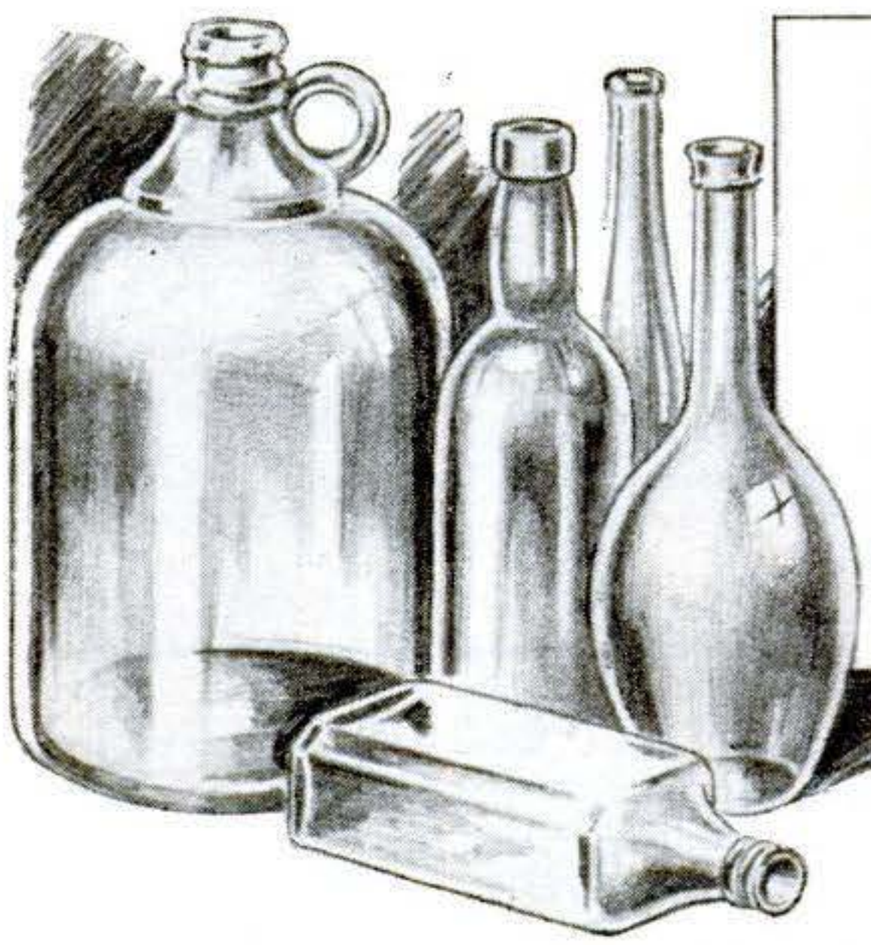
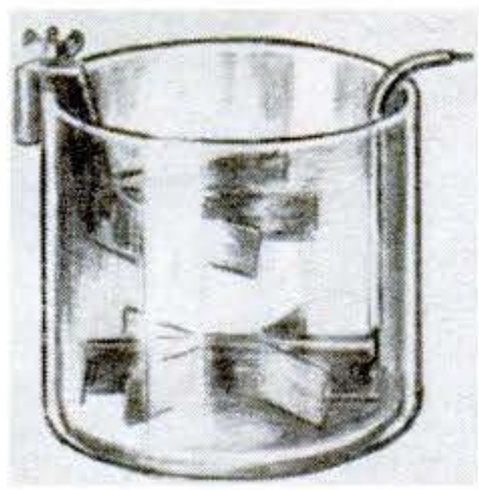
Electrically Cut Bottles





Battery Jar

Fish Bowl

Chemical Tank

By HAROLD P. STRAND

YOU can make many useful containers from glass bottles or jugs simply by cutting off the necks and, sometimes, the bottoms. An electrical-resistance hookup provides the best method of cutting such a utensil without shattering it.

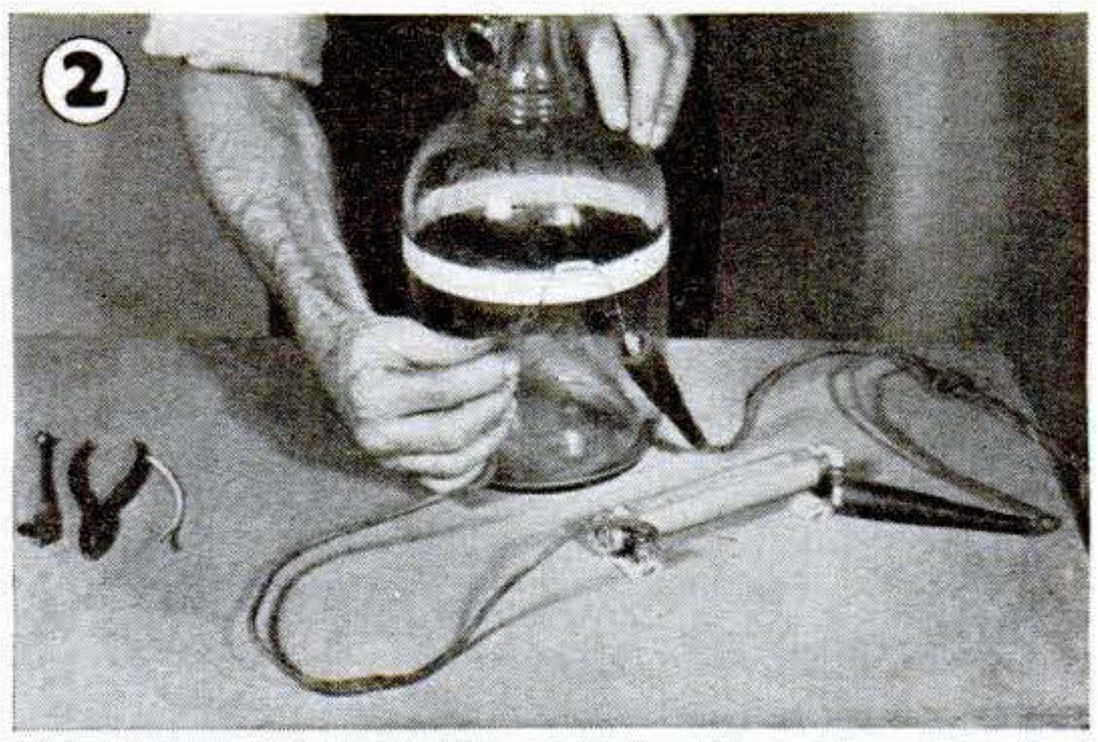
Wrap a length of adhesive tape around the jug at the point where the sides start sloping in to meet the neck. Using a sharp glass cutter, scribe the jug along the top of the tape, as in Fig. 1. Wind a single turn of resistance wire, preferably 24 gauge, around the jug on the scribed line, bringing the ends tightly together and holding them with a piece of asbestos-covered solid wire.

A heavy-duty lamp cord is used to transmit the necessary current. Separate the two wires and splice one directly to the resistance wire. Connect the other to a resistor of about 20 ohms that will carry 5 amps. A toaster or a flatiron is good, or you can use a replacement element intended for use in such an appliance. Fasten a length of insulated wire to the other end of this resistor and scrape the insulation off the free end of the wire for a distance of about ¼".

Now touch this wire intermittently to the free end of the resistance wire that is wrapped around the jug. The latter will heat up—don't let it get beyond the point where it glows dull red. After a few applications of the current, a cracking sound will tell you that the heat is starting to separate the glass along the scribed line. If the wire fails to heat enough, check on the wire and resistance; with a 660-watt resistance element, use 24-gauge wire, and with a 1,000-watt element, use 20 gauge.

Help the cracking process by tapping the glass with the ball end of the glass cutter. If the resistance wire slips out of place while power is being applied, anchor it with three or four tabs of adhesive tape, spacing them equally around the jug. These may scorch, but the scorching won't affect the glass. When the cracking process is completed, the top section of the jug can be lifted off as shown in Fig. 3.

There are at least two methods of finishing the cut. One way is to remove the tape and carefully to file down the sharp edges. Another and better way is to bind the top with waterproof adhesive tape. Apply two



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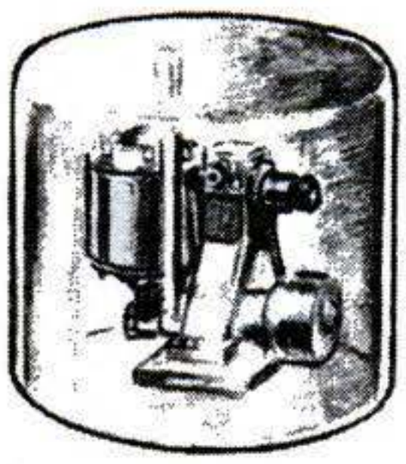
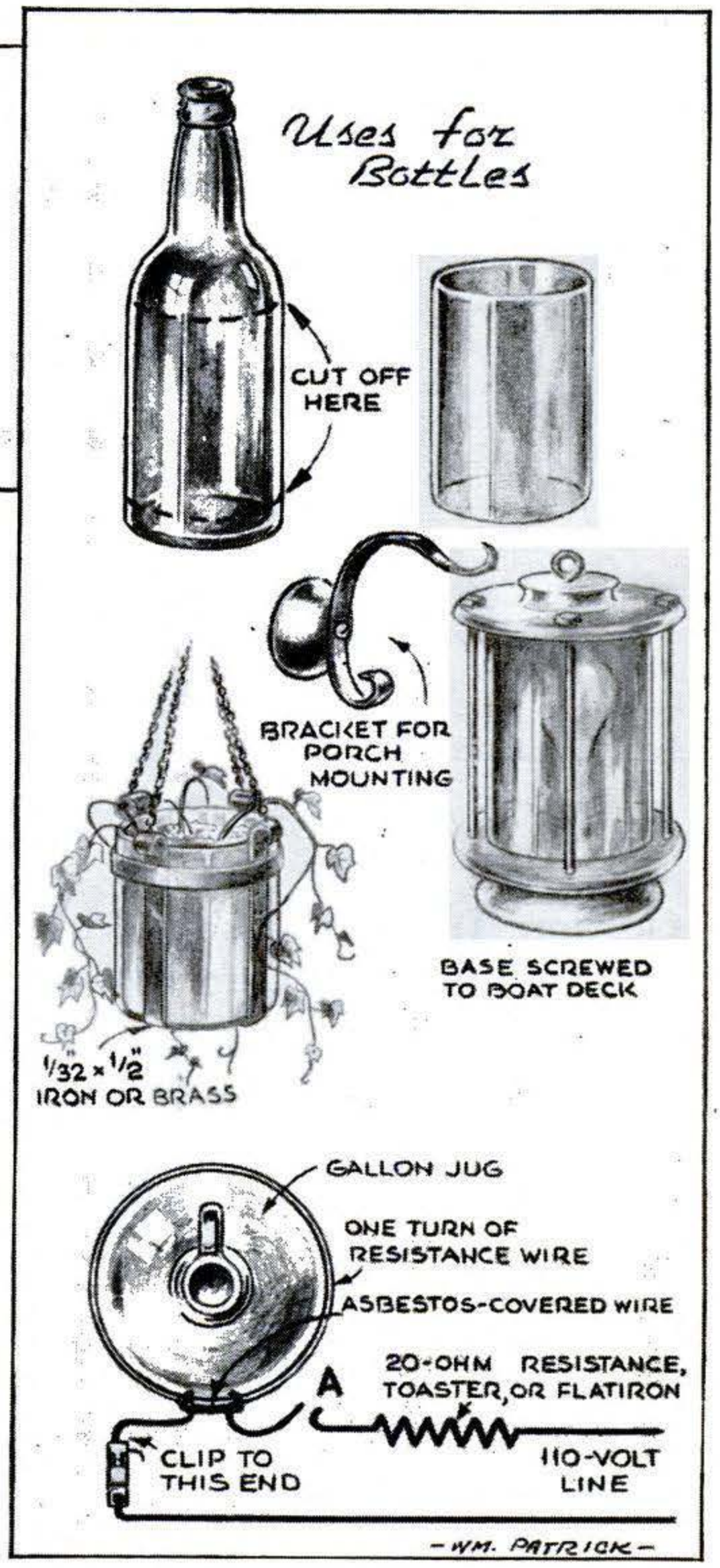
Form Unusual Containers



Model Case

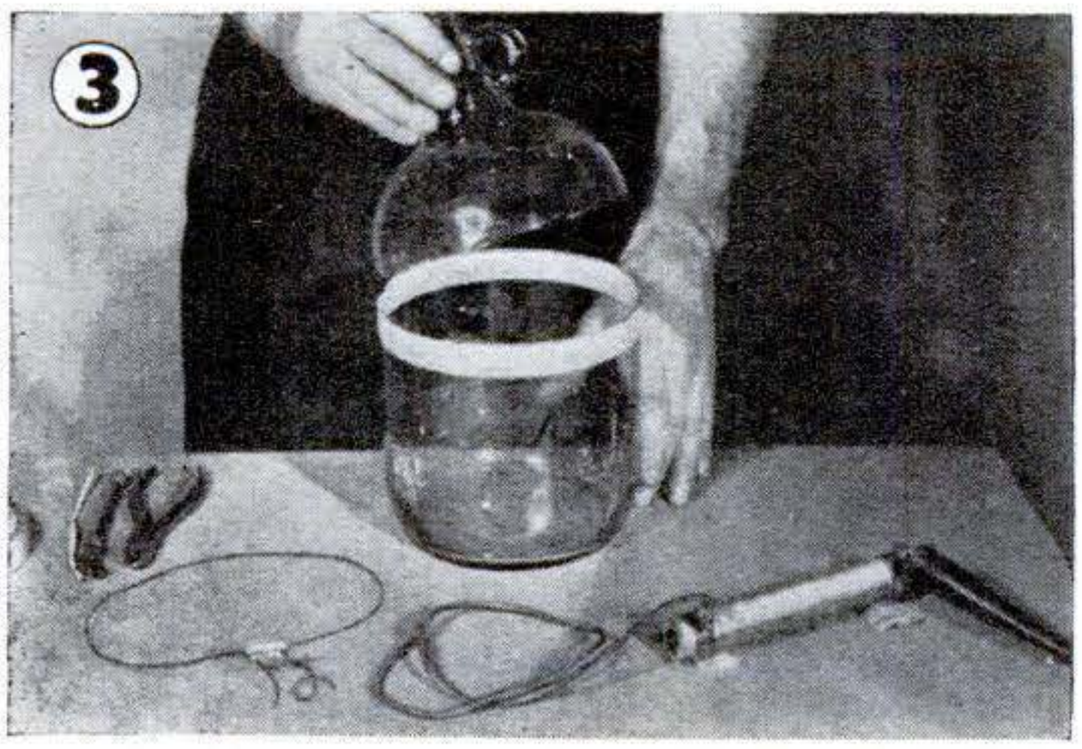
Instrument Cover



coats of waterproof lacquer to the tape, as shown in Fig. 4.

The finished product will have a capacity of about three quarts. You can use it as a wet-cell jar, a fish bowl, or a chemical tank, as shown in the drawings above; or employ it in your shop to hold metal-pickling acid; or turn it upside down and use it for a model case or a cover for your microscope or chemical balance. If you make a dust-resistant lid for it from two wooden disks nailed together, the lady of the house can use it when she cures or pickles foodstuffs. One disk should be slightly smaller than the inside diameter of the jar, the other should equal the outside diameter.

A bottle of the sort that is shown at the upper right, cut as indicated, can be used as the glass cylinder in a marine-type lamp. Make the top and bottom pieces of the fixture from hardwood or metal. Hold the assembly together with four bolts made from 3/16" brass rod. For use on a porch, hang the lamp from a wall bracket; on a boat, screw the base to the underside of the overhead deck. A similar bottle can be adapted for use as a hanging plant container, as shown in one of the accompanying drawings, by making a cradle for it from three pieces of 1/32" by ½" iron or brass strap.



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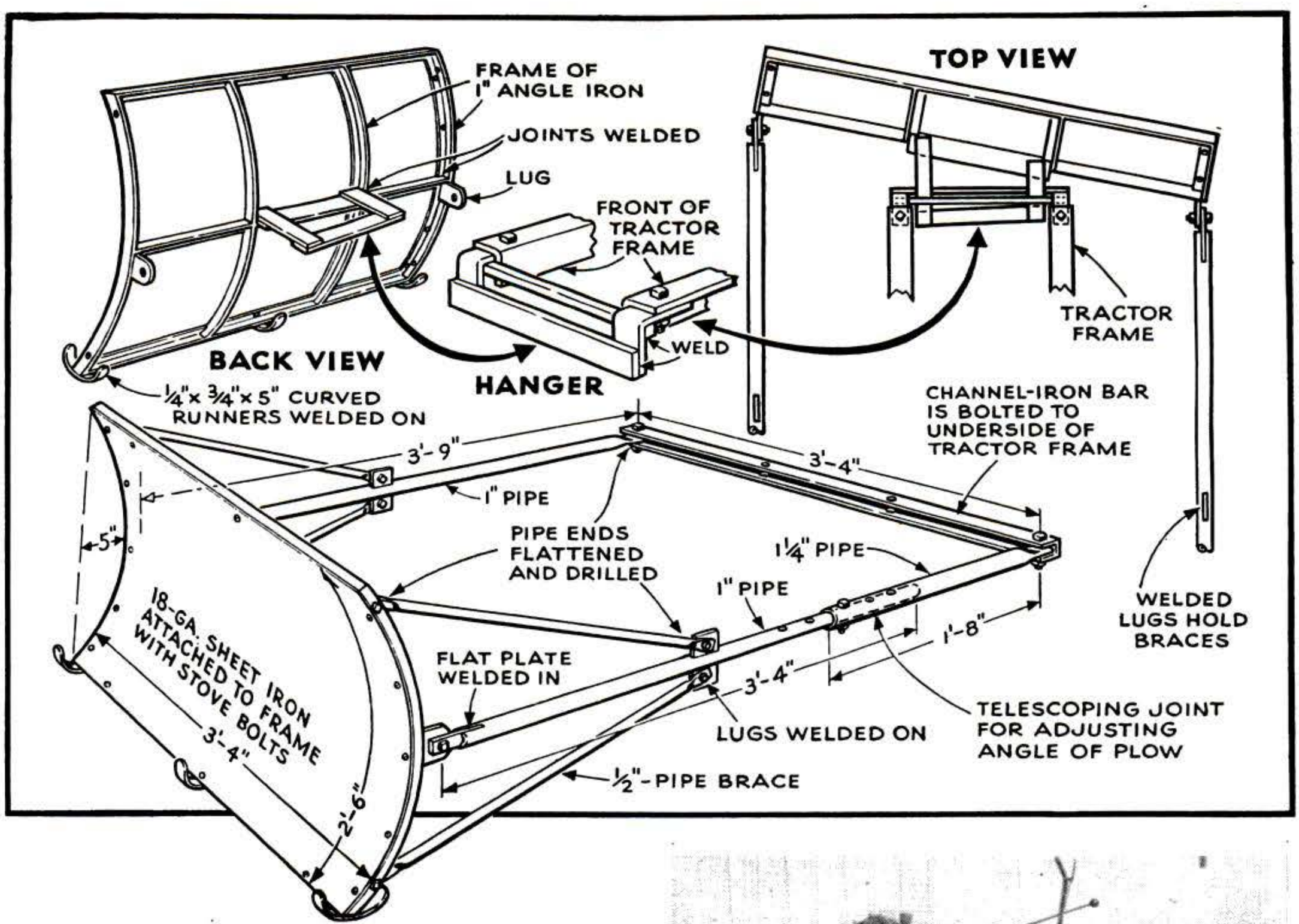
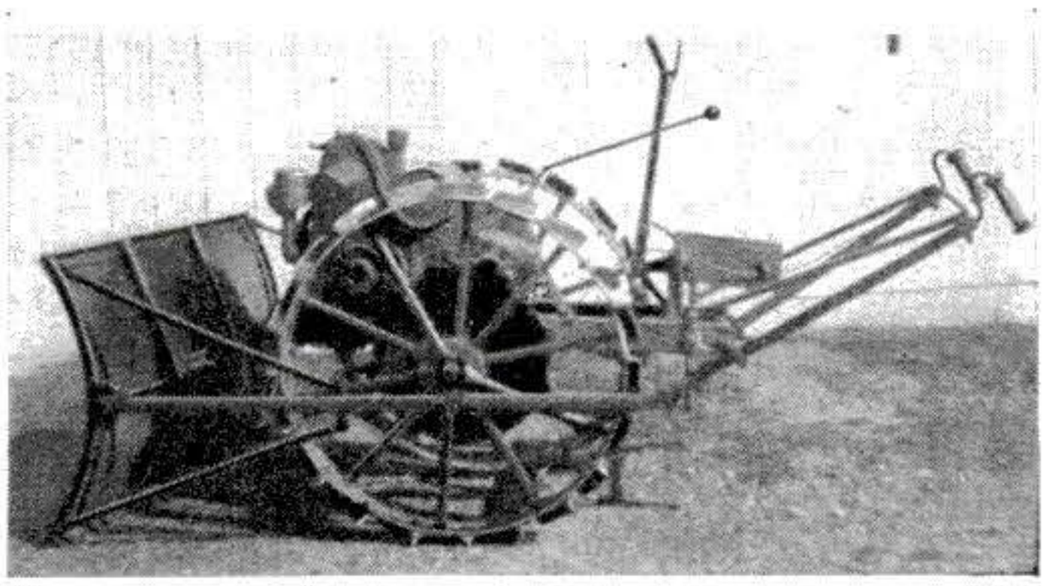


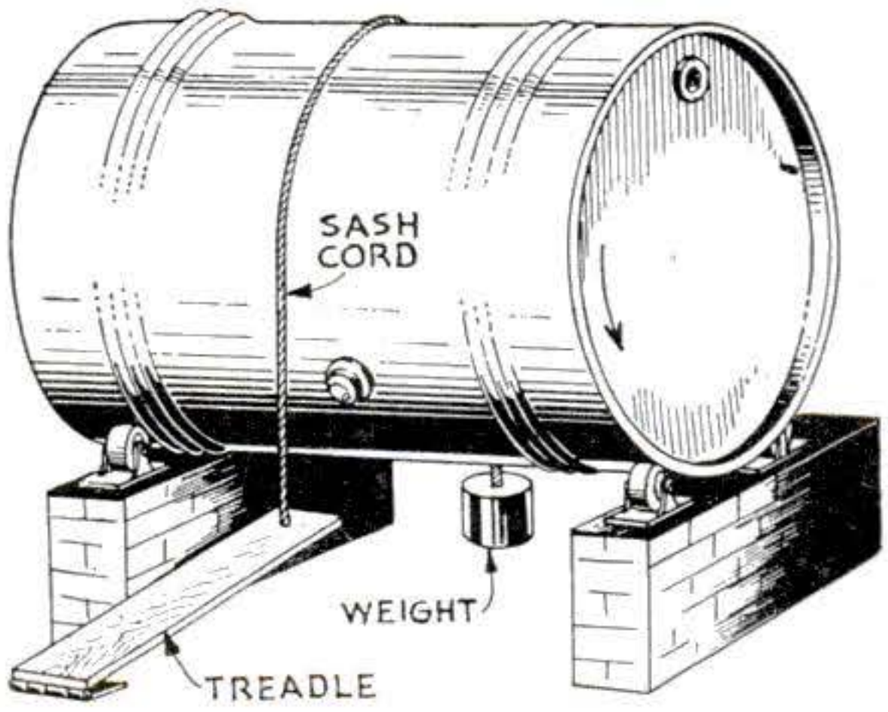
Garden Tractor Is Converted to Snowplow to Clear Walks



GARDEN tractors can be made to do double duty by using them in the winter months to remove snow from sidewalks and driveways. The one shown works well even in snow of considerable depth, for the steel wheels, fitted with diagonal lugs, have little tendency to slip and spin.

It will be noted in the drawing that, although the 1" pipe frame of the plow surrounds the tractor, some thrust may be transmitted through a bracket and hanger attached to the plow and to the front of the tractor frame, respectively. One of the side members is constructed with a telescoping joint and removable pin so that the angle of the plow blade may be adjusted to suit different conditions. As a rule, the deeper or heavier the snow, the sharper this angle should be.

The dimensions given in the drawing are for a 4-hp. tractor; if one of less power is used, the blade should be made somewhat narrower.—RALPH S. WILKES.



Rotating Fixture with Treadle Permits Continuous Welding of Round Work

CONTINUOUS welding of cylindrical objects such as steel drums or hot-water tanks is made easier with a fixture of the kind shown at the left, suggested by the Linde Air Products Company. The sash cord should be just long enough to let the weight touch the ground when the treadle is up. As the welder slowly depresses the treadle, friction of the cord will cause the work to rotate toward him. When he raises his foot the weight will pull the cord back, but the work itself will not roll back.

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I Ride "the Beast"

(Continued from page 133)

up enemy task forces. It worked in the Battle of the Coral Sea, at Midway, Guadalcanal, and Rabaul.

On sea targets we would dive on anything the Japs were foolish enough to put in our sights. The fighters would strafe the decks, then fly cover above us. Below us the torpedo planes would sweep in and administer the *coup de grace* after we had our targets dead in the water.

Against land targets we would use substantially the same tactics. Land targets were easier. They didn't move. There we would get in the best licks with our wing guns.

The first objective of the task force to which we were attached was Saipan. The Marines were to take Guam. This was D-day minus 3, and our job was to soften up the defenses. We also were to help neutralize Jap air power in the area.

We hit Guam. Orote peninsula crawled with Jap antiaircraft emplacements. They were hard to see from the altitude at which we "pushed over"—that is, where we went into a shallow dive. Usually it wasn't until we were halfway down that we spotted the AA "winks." Then we would have to go on very low into a rain of automatic-weapons fire to put our bombs where we wanted them.

We used the cannon to start fires.

Our force pulled away and cruised north to hit the Bonin Islands to neutralize the Jap bases there and prevent interference with our investment of Guam.

When we came back, a strange show was going on. Without risk to their carriers (they thought), the Japanese were launching hundreds of planes against us. Their idea was simple. It was good. It just didn't work. The Jap planes were to shuttle-bomb —plastering our invasion forces and then flying on to Guam. There they were to refuel, rearm, and plaster us again.

Meantime, their carriers were to stand off out of range of our fleet.

The double trouble for the Japs was that our fighters shot down their planes practically as fast as they appeared, and what few did get through couldn't use Guam because we had dive-bombed the airfield until its surface looked like a Swiss cheese.

Somewhere, there west of us, was a Jap fleet. We waited. Finally the orders came.

We didn't know it then, but we were going to participate in the First Battle of the Eastern Philippines. It would be a long strike, 300 miles or so. The Helldivers had much more range than earlier dive bombers. They had more than 1,700 horsepower on their noses, whirling three-bladed steel propellers.

But, even so, we ran the chance of losing all the planes we launched. The point, of course, was that the richness of the target was worth the risk.

Bombing One pilots and gunners climbed into their planes. Despite the size and weight of the Helldivers, take-offs were simplified by aerodynamic refinements. Outboard on the leading edges of the wing were "slots," which go into operation when the leading gear is lowered, assuring lateral control at low speeds. When the needle on the air-speed indicator was at a dangerously low point, a part of the leading edge of the wing would pop out to channel an auxiliary flow of clean air over the ailerons.

One by one we rolled down the length of the deck, rendezvoused, and settled into formation. Off to the right the planes of other flat-tops were heading west.

It was a long flight. Presently two of my planes got croupy engines and turned back. That left 13.

Except for the blobs of cumulus clouds, it was a perfect late afternoon. Here and there the clouds obscured the sea.

Even before we flushed the Japs we knew they had been found. The first elements of our striking force relayed the news in code. They were killing time, awaiting our arrival.

Then, of a sudden, our target was ahead of us in plain sight. It was huge. It stretched to the horizon, all around. There were flat-tops, battleships, cruisers, destroyers, and the inevitable "train" of supply ships. It all looked peaceful enough as the afternoon sun slanted on the water. Two of the vessels, toy ships on a pond, were refueling. Astern, flanked by two or three cruisers and some destroyers, was a big *Shokaku*-class flat-top of 30,000 tons. Its deck was bare.

For a dive-bombing pilot, this was smorgasbord.

"We're going after the big one astern," I radioed the leader of our torpedo-bomber squadron. I glanced around. All of my boys seemed O. K.

We nosed over at 15,000 and were doing 260 knots in our high-speed approach. We opened the bomb-bay doors and pushed over —steepening the dive—at 9,000 and opened the diving flaps. The flaps, or air brakes, are inboard on the trailing edge of the wing. In position for a dive, they angle upward and downward to form an elongated V.

The big bomb is carried internally, for the

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first time in the Helldiver design, to streamline the plane and provide more speed. The ship is fast enough to keep up with its escorting fighters, the Hellcat and the Corsair.

Antiaircraft guns began winking at us. The flak floated past, reddish-brown, white, and silver. AA fire comes straight at you, and you wonder why it doesn't hit you.

The carrier began turning. It turned amazingly fast. That worried me. My plane as yet was not in bombing attitude. I wouldn't go into a 70-degree dive until I was down to some 5,000 feet. I was leading the carrier with my sight in an effort to lay the bomb in the middle of its deck. I kept riding the rudder pedals.

Dive bombing is a matter of estimation—estimation of the wind, the speed and course of the target, and the amount of time it will take your bomb to drop from a given altitude. You watch your altimeter, compensating in your head for the "lag" it shows behind your actual altitude.

There is little sensation to a dive. You know you are picking up speed. The pressure on your eardrums tells you so. Your senses are alive to everything, even the littlest item. The target keeps getting bigger. The whitecaps, which from upstairs looked like white fluff on glass, begin taking on motion.

The flat-top was trying to complete a circle. I steepened my dive. In a moment the altimeter said "go." I pressed the button, automatically reaching for the manual release to make sure the bomb was gone. With the next motion I closed the diving flaps and bomb-bay doors and pulled out.

Pull-outs are a lot worse in fiction than they are in fact. Your legs feel heavy for a moment. Your sight sometimes dims, as though someone had clipped you on the chin with a boxing glove. Then it's all over.

I raced away, riding the rudder, hauling and pushing on the stick to make my plane a poor target. Things happen in slow motion in battle. I flew for what I thought was a long time. Then I turned to count my planes. Instantly tracers began outlining the Helldiver in red. I resumed course, taking violent evasive action. Pretty soon there were no more tracers.

I called up my squadron on the radio. Fuel was low. It would take time to rendezvous, so planes would have to return in independent groups. Five of my planes joined up with me. I wished we could wait for the rest. We headed east.

It hadn't been a bad strike. Three members of Bombing One had hit clean. My bomb had been a near hit. The flat-top was burning so well that the last two pilots to push over decided not to waste their bombs on it. They attacked a cruiser.

Fire is the bane of the flat-top. If you can penetrate the deck plates, the chances are you will ignite the oil and high-octane gasoline stored below. Normally that stops it dead in the water. A flat-top's watertight compartments make it hard for dive bombers to sink it, but the torpedo planes do a nice job of finishing it off.

It looked as though the torpedo planes had registered three hits on our target. Other ships in the Jap fleet had taken a pounding, among them a *Kongo*-class battleship. A *Hayataka*-class carrier was sunk. Another in the same class was damaged. A cruiser and three destroyers were hit. Three tankers were sunk, two others left burning.

Our planes flew eastward, throttled back to conserve gas. The sun went down. Dusk came, then night. The fuel needles crept across the faces of the dials. It looked bad. I kept rehearsing the sequence of what to do in a water landing.

My fuel needle wavered uncertainly at the far corner of the dial. Now it was almost on the little peg at the corner. This was it. I waited for the engine to gasp and conk out. And right then, as though in answer to a prayer, we looked down on the home hearth.

A lot of planes went into the water that night. Some "splashed," as Navy parlance has it, short of the fleet on their way home. Some milled around above the fleet, trying in the melee to find their home decks, and failing. Some landed on other carriers.

The destroyers were everywhere, wet from stem to fantail as always, pulling dripping pilots and gunners aboard.

I happened to make our carrier—with five minutes' fuel left in my tanks. A cursory roll call brought little response. I kept saying to myself, "Well, it was a damn good squadron while it lasted." I could think only in the past tense. My pilots, my gunners, my planes, were gone.

And then, one by one, destroyers began drawing alongside and the men of Bombing One began clambering aboard our flat-top. Pretty soon I had half my flight, then three fourths of it, and at the end of three days every man Jack had returned. Our casualties: one cut finger.

If all the awards I recommended come through, the men of Bombing One are going to have a lot of decorations on their blouses. They deserve them.

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Wheels That Can't Slip

(Continued from page 125)

one of these various kinds of cutting machines. So the blanks are held tightly in the desired position. This is done with locating pins which are held in a mechanism controlled by compressed air. By turning the air pressure on or off, the operator can release or tighten the blank in the machine with a flick of the wrist.

All of the cutting entailed in the manufacturing of metallic gears is done in jets of the proper cutting fluids. Since the gears, when used in flight instruments, may be subjected to both desert heat and arctic cold, the most faithful of metals are used. And since even a pinpoint of rust might affect the accuracy of the instrument containing the gears, extreme care is taken to prevent corrosion.

Inspectors sit alongside the operators of the automatic cutting machinery and test every piece of metal repeatedly. The diameter, drill hole and shape of each blank are checked. And every finished gear is tested as to size, concentricity, smoothness when rolling with a master gear, and for burrs or sharp edges on the teeth.

When assembled in units, the gears are further tested for smoothness and backlash. Much of this checking is done with a stroboscope, an instrument that indicates minute fluctuations from uniform or constant speed while the object under inspection is in motion. And, of course, there is a final test when all the gears are assembled in the proper places in the main instrument housing, for every one of them must do its stuff with far greater precision than a dancer in the famous Radio City Music Hall chorus line.

"As man continues to achieve higher and higher speed, power, and efficiency for his mechanical contrivances," says K. E. Bauerle, gear engineer of the Sperry Gyroscope Co., "he also becomes increasingly aware of the necessity for improving the precision, performance and durability of his most precious machine element—the gear.

"The gear has come to be properly regarded by him as the reliable co-ordinator of the numerous types of motions which he is forever scheming into his mechanical devices. It has become the nucleus about which he arrays the levers, wheels, shafts, and pistons that do the world's work for him."

The war has accelerated the mass production of fine-pitch gears to direct engines of death. Such gears also can co-ordinate and guide peacetime work with speed and accuracy.

How Good a Weather Prophet Are You?

Here are the answers to the weather quiz on page 130. Check your results and see how well you made out.

1. *FALSE*. Humidity, clouds, and other phenomena collectively known as weather, extend to only about 30,000 feet.

2. *TRUE*. A warm air-mass invasion pushes its head into the substratosphere and causes "mackerel skies," etc.

3. *TRUE*. The altimeter is really an aneroid barometer.

4. *TRUE*. Ice forms rapidly in the turbulent changes of cumulus clouds.

5. *FALSE*. A cloud ceiling is the base of a cloud formation.

6. *TRUE*. A warm front extends over large areas (about 1,000 square miles) and moves more slowly than a cold front.

7. *FALSE*. Close-together isobars indicate steep changes and high winds.

8. *FALSE*. Winds increase with altitude, being free of surface friction.

9. *TRUE*. Rain seldom falls from the higher clouds.

10. *TRUE*. The weight of air presses with a force of about 15 pounds per square inch at sea level.

11. *FALSE*. A high-pressure area is a good-weather area.

12. *FALSE*. All-metal ships give protection against lightning.

13. *FALSE*. The cumulo-nimbus throat has terrific updrafts.

14. *TRUE*. Hailstones are frozen rain pushed up in thunderhead drafts.

15. *FALSE*. Mare's-tails are cirrus wisps.

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"Green Gold" of Wyoming (Continued from page 114)

handsome prices. After awhile it dawned upon him that this was better than the hardware business. He sold out and now gives all his time to hunting the precious stones, selling some in the rough and cutting all he can. One firm is taking his entire output of finished pieces, and he says he could dispose of much more if he had the equipment and help.

Rhoads is half owner of the 3,366-pound stone, for it was Mrs. Rhoads, with a friend, Mrs. Ray Morgan, who found it. The huge boulder is lying in the Rhoads back yard. They are in no hurry to sell it, for their valuation of it keeps going up as they learn more about the real worth of jade.

A wandering mineralogist, searching for agates, seems to have been the first to recognize jade in the Wyoming area. Picking up a rich, green pebble, he looked at it sharply, looked again, and exclaimed to his native guide, "I'd rather have a mine of this than a gold mine. This is jade."

Oddly enough, this significant remark caused no stir in the community. The mineralogist went on his way. Now, nobody even remembers his name. That was eight or nine years ago. And then one day Allan Branham took a notion to send some of the green rocks east and see if he could get anything for them. People laughed at his idea of wrapping up stones and shipping them. But soon the checks started coming in, and with them came urgent requests from jewelry manufacturers for more of the rocks.

Word spread around Lander and the rush started, but it was still slow to get under full steam; most of the people simply wouldn't get excited about the green stones they had been seeing all their lives, lying about on the hills and in the valleys.

All the jade rocks and boulders found in Wyoming have proved to be jade all the way through. It has the usual variaton in quality, some being suitable for the finest jewelry and some for cabinet work, but all of it is valuable.

Geologists assume that the jade was thrown up by some immense natural upheaval centuries ago. The jade rocks are not rounded and smoothed as they would be if they had been brought into the territory by glaciers. Some have been partly smoothed by erosion, but others are sharp and jagged.

There are two kinds of jade, nephrite and jadeite, about equally valuable. All of the Wyoming mineral is nephrite, as is the majority of that carved so beautifully by the Chinese. The color of jade is extremely variable, ranging all the way from black through to brown, olive green, apple green, and even white, with countless combinations of these. Each piece has its own individuality and the expert cutter designs his finished article of jewelry in accordance with the possibilities of the material. It is a special art developed by the Chinese, who have excelled at it for centuries. So-called Chinese imperial jade, which sells for as much as $500 an ounce, is cut from a rare kind of streak occurring in some pieces of nephrite. Wyoming has produced some of this top quality.

Prices obtained by the Wyoming jade hunters are going up progressively as they gradually realize the true value of their native stones. Some jade was sold as cheaply as $1 a pound, but hardly anybody is so foolish now. Current selling prices for the rough material are somewhere in the neighborhood of $15 a pound, as compared with $50 and $60 paid by the Chinese for no better jade from Turkestan and Burma. Sheep herders, cattlemen, and ranchers are learning that it is worth while to pick up the pebbles and stones they discover on the range. They bring them into the towns of Lander and Riverton and sell them to local citizens who are in the jade business.

Even in the areas already thoroughly searched, occasional rich finds are still made. Those who have become professional jade hunters now go about chipping pieces off rocks that do not immediately reveal they are jade because they are covered with lichens or have not been exposed long enough to have been polished by wind-blown sand. The only handicap is that there is a lot of rock in Wyoming.

Erosion constantly uncovers more of the precious mineral. How much of it there is can only be imagined, but there is every reason to suppose that it is a prodigious amount, possibly the richest jade find in all history.—GOLD V. SANDERS.

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WHERE HAVE WE MET BEFORE?

The Army-Navy "E" flies above six Fisher Body plants for excellence in aircraft production and from two others for tank production, while the Navy "E," with five stars, is flown by still another Fisher Body plant for its naval ordnance work.

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RETAILED ONLY BY FREE, INDEPENDENT BUSINESS MEN DISPLAYING THIS SIGN OF QUALITY

The Bazooka's Grandfather (Continued from page 69)

and disintegrate. In TNT, this wave may travel five or six miles a second, and in some other explosive substances it goes even faster. It can jump across short air gaps, yet sometimes can be stopped with surprising ease by interposition of a comparatively thin layer of some sturdy material. The turmoil of the explosive's molecules, as the wave progresses, creates force, which moves outward at right angles to the surfaces of the charge.

In the hollowed-out portion of a shaped charge, this force coming from the sides of the cavity is concentrated into a jet. This jet has greater energy, pressure, and heat than the force that emerges from the flat, outer sides of the charge. The explosive waves are merged and focused as though they were streams of water, or rays of light, or waves of sound—and their effectiveness is greatly enhanced.

By changing the shape of the conical cavity, the width of the jet can be varied. A shallow cone, for example, causes a fairly wide jet and a deep one causes a narrow and more intense jet. Hence, one type of cone is used to punch a wide but shallow hole in an object, and another type to create a deep, tubular hole.

Suppose now, that, in addition to the waves of hot gases and explosive force spurting from a charge, pellets or fragments of metal were included in the jet. The destructiveness of the jet obviously would be made even greater. And this is exactly what has been accomplished by placing suitable linings, made of thin metal or some other material, in the conical cavities of shaped charges.

Linings have been developed which are literally turned inside out by the concentrated explosive force. When thus turned about they become teardrop-shaped pellets which are driven into the target. Other linings are torn into tiny fragments quickly by the explosive force and those fragments are hurled at the target. As visualized by ordnance experts, the tiny fragments lead the way, followed by larger ones, and thus a hole is punched in the target that grows wider as the jet continues on its swift, destructive way.

With a shaped charge of TNT weighing only 10 pounds, a hole 1¼ inches wide can be blown through eight inches of steel armor plate, or a hole twice that wide can be punched through a 30-inch reinforced-concrete slab. And, by firing a second shaped charge of TNT at the same spot, that hole can be widened and deepened.

Such invasions of armor and concrete are possible with the smallest of three standard-shaped charges supplied to the engineers for demolition blasting. By using a slightly bulkier, but no heavier, shaped charge of a new explosive mixture that is more powerful than TNT, the wreckers can blow a wider and deeper hole in either steel or concrete with a single explosion.

And, for really tough demolition jobs, the engineers use a heavier shaped charge. One blow from this one will punch a hole through five feet of reinforced concrete. If that concrete is part of a pillbox, the interior will be filled with bits of metal, hot gases, torn-off chunks of concrete, and other flying debris that will make life unendurable for the occupants. And if this violence is not sufficient, a long, narrow bangalore torpedo or a flame thrower can be shoved through the hole left by the shaped charge and used to complete the destruction of the occupants of a pillbox.

If Japs are hidden beneath log or steel-drum bunkers, one of these big shaped charges can be set on top of their cubby-hole and detonated. The charge will completely penetrate four feet of earth and four layers of 12-inch logs, sending hot metal fragments into the emplacement and filling it for five minutes with highly disagreeable smoke, debris, and dust.

If a more massive concrete obstacle must be removed, an engineer can set one of his big shaped charges against it and produce a hole about 60 inches deep, five inches wide at its mouth, and three inches wide at its bottom. A hole that size is plenty big enough for the insertion of more explosives to do whatever additional damage is desired. Yet the shaped charge makes such an opening as readily as you can drive a needle into loose sand.

These shaped charges, moreover, need not be clamped tightly against the surface that is to be punctured. The Germans have put magnets on the sides of some of their hollow charges to hold the charges against metallic plates. But if a horizontal surface is to be punched, the weight of the shaped charge is sufficient to hold it in place. If a hole is desired in a vertical wall, the shaped charge can be propped against the wall with a light pole, or hung from a wire like a picture frame.

But shaped charges need not always be carried to their target by hand. They can also be conveyed in rockets. In fact, one of the most important applications of the Munroe effect is in giving relatively slow-

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America's oldest industry—the fishing industry—has benefited in peace and in war from AC's easy plan for maintaining spark plug efficiency. Regular cleaning and adjustment, by AC methods, have helped thousands of the fishing industry's motor trucks to speed their perishable cargoes to market or cannery. Worn plugs, of course, are promptly replaced with AC's for *utmost reliability.* Thus, another of America's essential industries shows *you* how to conserve *your* transportation,—have your spark plugs cleaned and adjusted every 3,000 miles, and install AC's—of the right Heat Range for *today's* driving—when the old plugs have served their term.

SPEED FINAL VICTORY — BUY WAR BONDS

moving rocket projectiles the penetrating power of high-speed shells.

The army ordnance bazooka projectile, for example, is a rocket containing a shaped charge. The striking end of the projectile is hollow, and behind this open space is the wide end of a cone. Back of this cone is the explosive. It is detonated by a fuse in the rear, and the explosive force is shot forward after the rocket has hit. This concentration of the force enables a man armed with a bazooka to shoot a hole in the side of a heavy tank. The design of the high-explosive end of big rockets is similar.

In a rifle grenade, too, the Munroe principle is applied. The forward end of the grenade is left hollow, and the explosive's force is focused on the target by a cone.

The use of this principle in ammunition, however, is not limited to rockets and grenades. It also is used advantageously in artillery ammunition. But this poses a problem that is almost the reverse of that encountered in designing other armor-piercing shells.

A standard type of armor-piercing projectile has a heavy steel nose and is shot from the gun with such tremendous velocity that this nose is driven through the armor before the explosive charge in the base goes off. But ammunition in which the Munroe effect is utilized has a hollow nose, which crumples when it hits the armor. The cone behind this nose then focuses the explosive force against the armor.

So, in designing the latter type of shell, the problem is to build a nose that will crumple just the right amount when it hits the armor, rather than one that will go through the armor. Unless the nose crumples exactly the right amount, the hollow charge will be detonated too near or too far from the surface of the armor, and the result may not be satisfactory.

The distance between a hollow-charge explosive and its target at the time of detonation is known as the stand-off distance. Experience has shown that it is highly important. When this distance is exactly right, the jet from a hollow charge hits with such tremendous force that it actually makes steel flow like thick mud.

Much depends, too, on the type and thickness of the cone's lining. If that lining is a few hundredths of an inch thicker in one place than in another, and hence a bit more resistant to the explosive force on one side of the cone than on the other side, the jet will wobble and lose part of its force.

Similarly, a crack or very slight unevenness in the shape of the cone or its lining may greatly reduce the Munroe effect. Even the speed with which the detonation wave

(Continued on page 216)

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Helping the sick get well

New lamp kills germs . . . Germ-laden air is purified by the new G-E germicidal lamp. It is already at work in hospitals, in battlefront operating rooms. Tried in a school classroom during a measles epidemic, only one-fourth as many children contracted measles, as compared with unprotected classrooms.

LAMPS that kill germs . . . X rays to guide the surgeon's fingers . . . air-conditioned operating rooms . . . The pictures you see here are typical of things accomplished for you by G-E research and engineering.

Seeing the invisible . . . The electron microscope, more powerful than ordinary microscopes, gives doctors a new tool to fight disease. Here is the germ, *bacillus subtilis*, magnified about 4,000 times. G-E engineers are working to make available a *portable* electron microscope for industry.

Mirror of D-Day injury! A mine shattered Seaman Brazinski's boat on D-Day, blew him 20 feet in air. Rescued by an LST, rushed to England, X rays quickly defined his thigh injury, permitted accurate setting. Portable G-E X-ray machines at St. Albans Naval Hospital, L. I., regularly check his progress. Through the skill of doctors 97 per cent of the wounded in this war are saved. The modern form of X-ray tube was invented by Dr. W. D. Coolidge, G-E scientist. X-ray units built by the G.E. X-Ray Corp. are at battlefronts the world over.

Helps treat Infantile Paralysis . . . Doctors wanted hot packs to relieve pain and reduce muscular spasms, but such steam packs tended to burn. G-E workers put together a machine for hospital use that produces heated packs that even at 180° F. will not burn the patient's skin.

★

Helping the sick get well is only one of the contributions of General Electric. From the research and engineering in G.E.'s laboratories come products to make your work easier, your home brighter, creating new comforts, better jobs. General Electric Company, Schenectady, N. Y.

Hear the G-E radio programs: *The G-E All-girl Orchestra*, Sunday 10 p. m. EWT, NBC—*The World Today* news, Monday through Friday 6:45 p.m. EWT, CBS—*The G-E House Party*, Monday through Friday 4:00 p. m. EWT, CBS.

FOR VICTORY—BUY AND HOLD WAR BONDS

GENERAL ELECTRIC

952-624-211

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DISTINGUISHED SERVICE

Everywhere they have performed distinguished service — powered the craft of valiant flyers as they won coveted decorations. ★ They've blasted Germans and Japs, and have served the Russians and British. ★ They've been America's own liquid-cooled aircraft engines since long before Pearl Harbor. ★ Because these engines are streamlined, pilots have better visibility. Because of their dependability, they are always ready to go. Because of their smoothness, there is less pilot fatigue. Because of their economy with fuel, their range is wide. ★ These are engine qualities that will be important to you in the days of far-flung air transport to come.

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang
P-63—Kingcobra

Allison has already furnished more than 75,000,000 H. P. for use in these planes.

LIQUID-COOLED AIRCRAFT ENGINES

Allison

DIVISION OF

Indianapolis, Indiana

GM GENERAL MOTORS

KEEP AMERICA STRONG
BUY MORE WAR BONDS

Every Sunday Afternoon —
GENERAL MOTORS SYMPHONY OF THE AIR—*NBC Network*

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Tough

BUT OH SO GENTLE

● Worn-out piston rings cause needless wear *inside* your engine, where you can't *see* the damage. And if they're not promptly replaced, the wear grows worse and worse—until, finally, your engine may quit you for keeps.

But, fortunately, piston rings warn you when wear becomes critical. Your engine smokes, wastes oil and loses its power.

At the first sign of ring wear, it will pay you to have your motor specialist install a set of Hastings Steel-Vent piston rings. They *stop* oil-pumping, *check* cylinder wear and *restore* engine performance.

HASTINGS MANUFACTURING CO. • HASTINGS, MICH.

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HASTINGS STEEL-VENT

PISTON RINGS

TOUGH ON OIL-PUMPING GENTLE ON CYLINDER WALLS

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IT'S A PRIVILEGE TO BUY WAR BONDS

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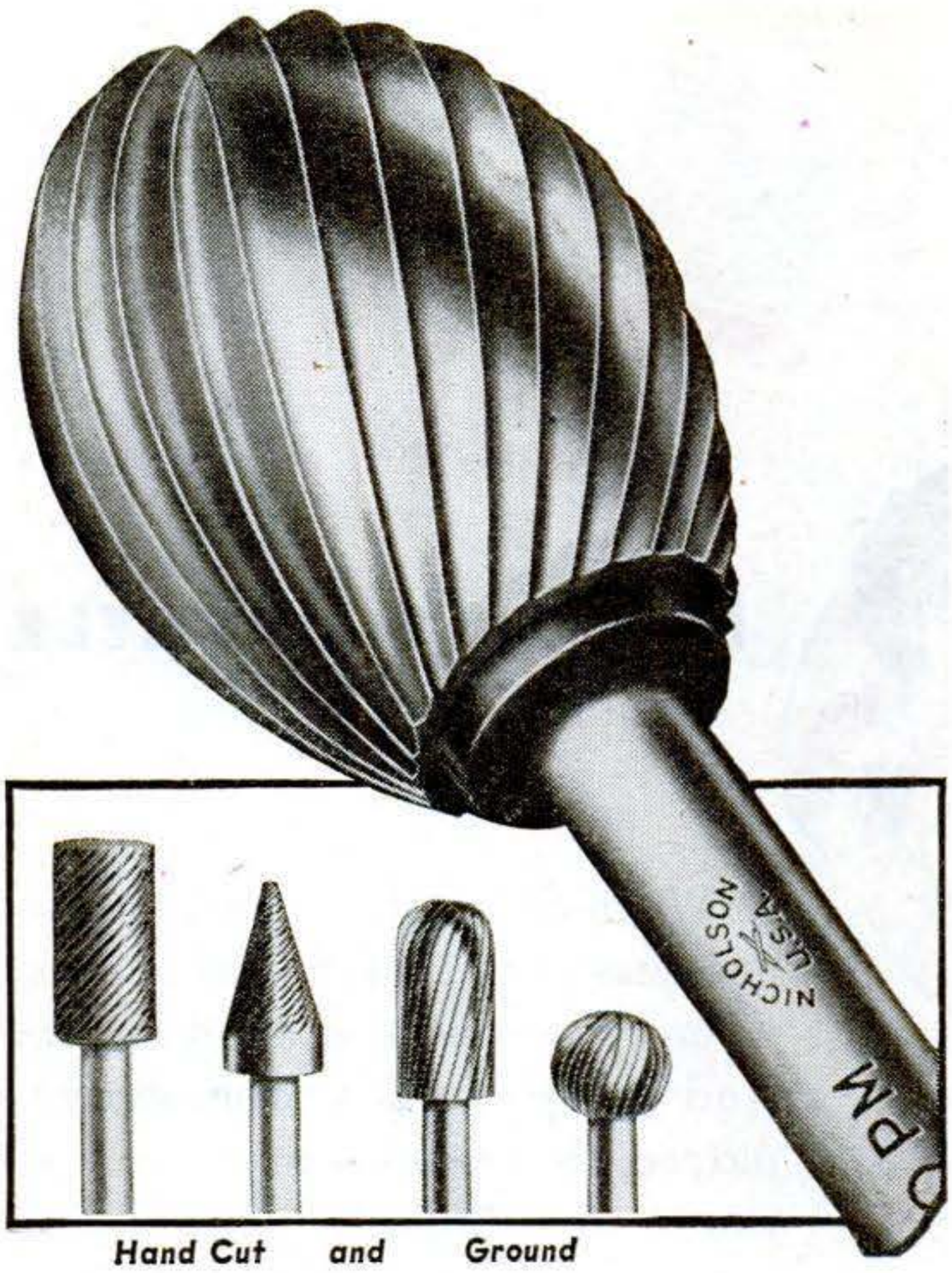

Hand Cut and Ground

NOW Rotary Files by Nicholson

With Rotary Files, the world's foremost file manufacturer extends still further the scope of the well-known Nicholson slogan, "A file for every purpose."

Nicholson Rotary Files are available in both *Ground* and *Hand Cut* types . . . each in 16 standard styles or shapes; 3 cuts (Coarse, Medium and Fine); 64 sizes and in diameters ⅛" to 2".

Nicholson Rotary Files are manufactured from high-speed tool steel; carefully shaped and true centered; accurately cut or ground; expertly hardened. . . . They must uphold, in every respect, the Nicholson guarantee of *Twelve perfect files in every dozen.* Obtainable through mill-supply houses.

CATALOG AND PRICE LIST will be sent, on request, to industrial, machine-shop and school-shop managements.

Nicholson File Co., 90 Acorn St., Providence 1, R. I., U. S. A.
(In Canada, Port Hope, Ont.)

NICHOLSON ROTARY FILES
(Hand Cut and Ground)
FOR EVERY PURPOSE
NICHOLSON U.S.A.

The Bazooka's Grandfather

(Continued from page 212)

starts through the charge is an important factor.

World War II has been partly a race between United Nations and Axis experts to learn more about the best ways to determine and regulate stand-off distances and to find the most efficient linings for the cavities of hollow charges. It has been a quest for precision. This race has been run by ordnance researchers, however, without benefit of cheers from the public, lest premature revelation of some bits of information help the foe to catch up. Tests that have been made with German and Japanese hollow-charge explosives indicate that the Allied ordnance experts are well ahead of their rivals.

The engineers' uses for shaped charges are manifold. Assume, for a moment, that a bridge must be cut. It can be done either by severing one or more spans or by knocking out supporting pillars. In either case, hollow charges can be helpful. They can be used to weaken a span by punching holes in it. But spans usually can be replaced more quickly than supporting pillars. So the engineers may choose to demolish the pillars. They can do this by punching holes in them with hollow charges, filling those holes with additional explosives, and thus leaving the whole bridge shattered as irreparably as Humpty Dumpty.

You may wonder, when you observe the shape of a hollowed demolition charge placed against a sturdy obstacle, why it does not simply fly off like a rocket when detonated. The experts' answer is that the explosive force is spent too swiftly, and is countered too effectively by the emergence of other force from other sides of the charge. The distance that a demolition engineer must stand back for safety's sake, when detonating his shaped charge, depends partly on the composition of his container—and this is another matter which has been the subject of research.

The extent to which the wild forces of an explosive wave can be focused, however, is truly astounding. If, for instance, a hollow charge with a deep cone such as is used for demolition work is turned toward the sky and shot off at night, the result is a pillar of brilliant, flaming gases, almost as slender as a bolt of lightning, but as straight as the beam from a searchlight.

When paper hangs the paper hanger, that's news! Your waste paper will help make a noose for Hitler.

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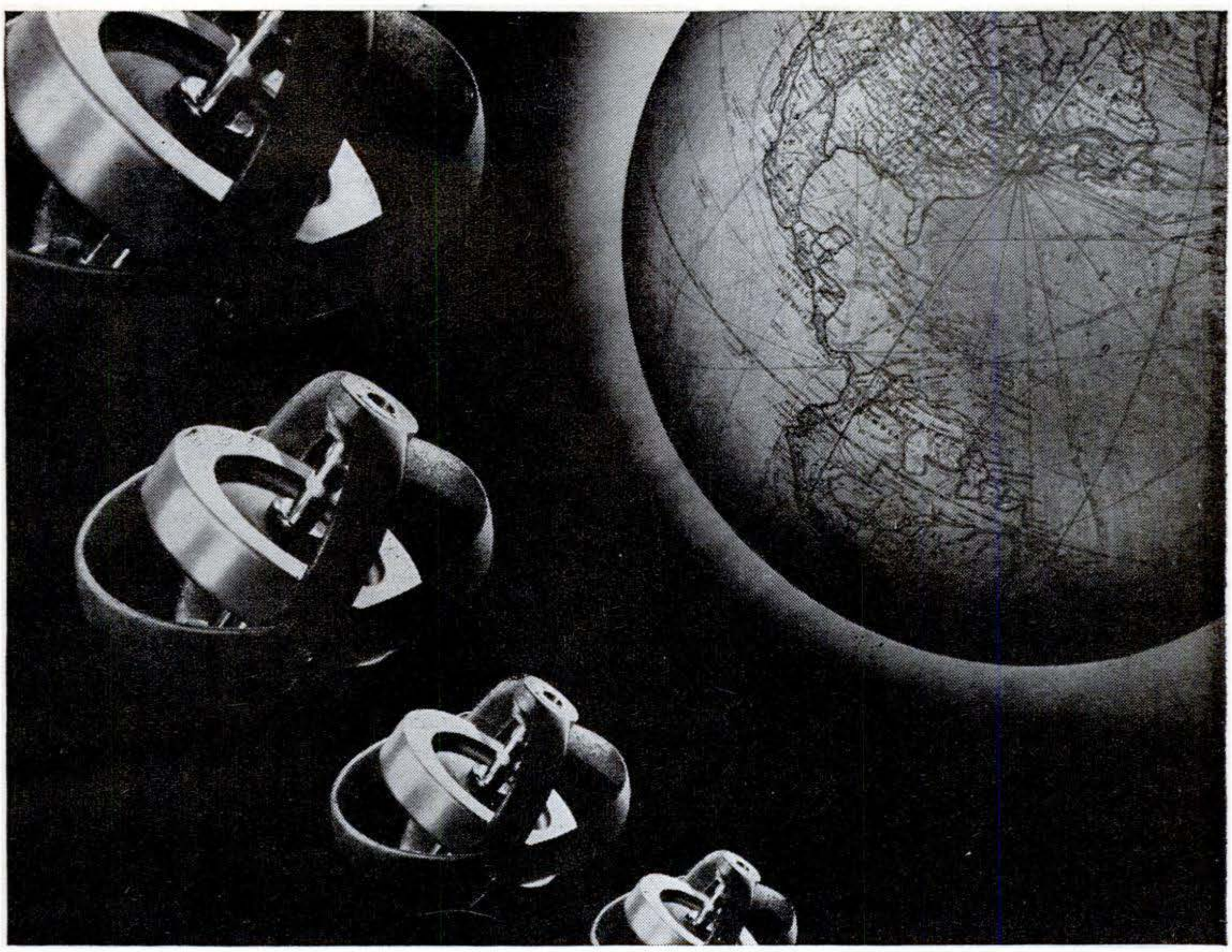

More than a million such wheels are now in use . . .

What is it?

This wheel is a gyroscope.

The world is a gyroscope, too.

Spinning freely in space, the world maintains its axis in a fixed direction in its orbit.

A rotating wheel, universally supported, will also maintain its axis in a fixed direction in space.*

This unique characteristic of the gyroscope makes possible some of man's most remarkable and useful instruments.

For example:

. . . blind-flying instruments which show pilots the way through the hazards of fog and stormy weather (SPERRY DIRECTIONAL GYRO, SPERRY ARTIFICIAL HORIZON).

*Sir Isaac Newton's first law of motion.

. . . a device which can relieve the human pilot and hold an airplane level and on its course for hours with no hand on the controls (SPERRY AIRCRAFT GYROPILOT).

. . . a non-magnetic compass which always points to true geographic north and guides our convoys through all kinds of weather (SPERRY GYROCOMPASS).

These are but four of nearly 50 essential Sperry instruments of war and peace in which the gyroscope plays the principal role.

Sperry is an organization specializing in the solution of precision engineering problems, many of which have been solved by application of the gyroscopic principle. Many of its products designed originally for peacetime use are now seeing service on every fighting front.

When the war is won, Sperry products—hydraulic and electronic as well as gyroscopic — will again return to the work of peace.

FOR PEACE ON EARTH—BUY WAR BONDS

SPERRY

CORPORATION

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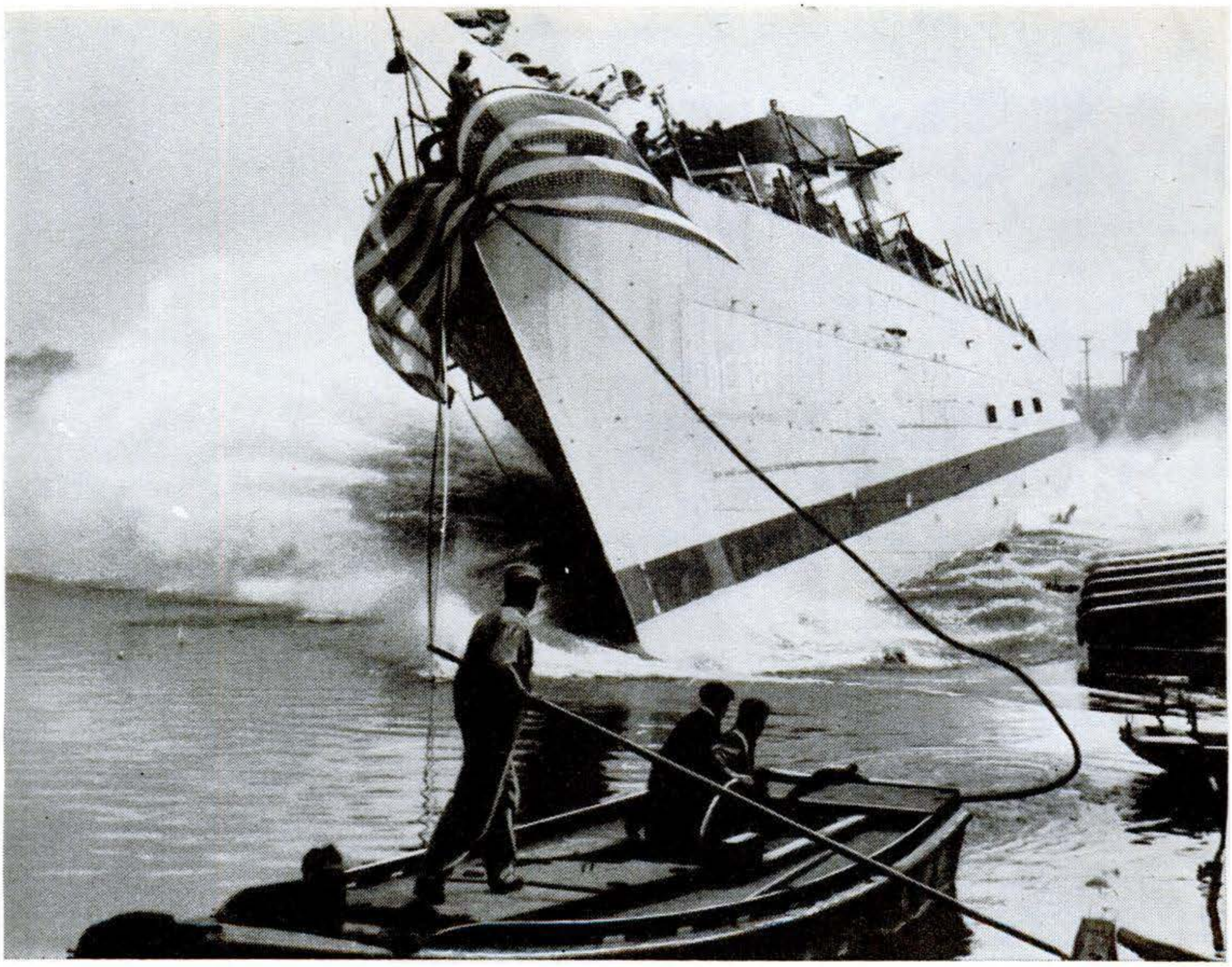

A Destroyer-Escort hitting the water from the Defoe launching ways

When We've Launched Our Last Warship

After the nations of the world stack arms and the last warship has been sent from our ways, this company, in stride with the leaders of American industry, will be ready for conversion to peace. More than that, we will be prepared to translate the advancements and economies taught by war into epoch-making new products for better living for Americans. As it has for more than 40 years, the Defoe Shipbuilding Company will construct large yachts and commercial vessels. But the major expansion will come in the new Housing Division which will manufacture and distribute low-cost units and component parts for American homes and farms. The industries of this country should turn the experience, new techniques and materials developed by war work toward advancing the standard of living throughout the world. The large-scale program of the Housing Division will be Defoe's contribution to mobilization of American war industries for peace time production and employment.

HOUSING DIVISION

DEFOE SHIPBUILDING COMPANY, BAY CITY, MICHIGAN

Four White Star Renewal Citations now decorate the Navy "E" Award won by Defoe workers.

BACK THE ATTACK —BUY WAR BONDS

Defoe

SHIPS FOR VICTORY SERVANTS FOR PEACE

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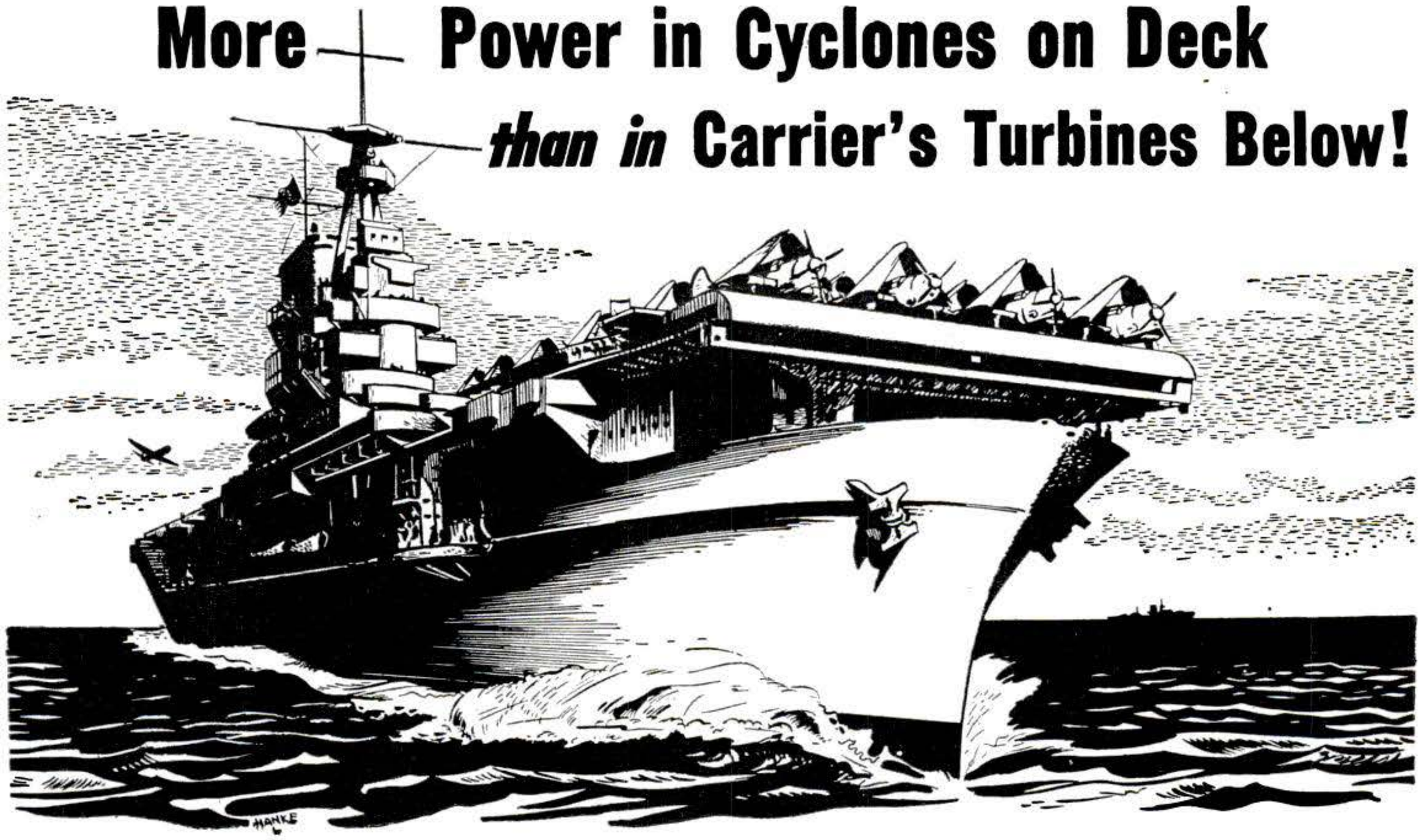
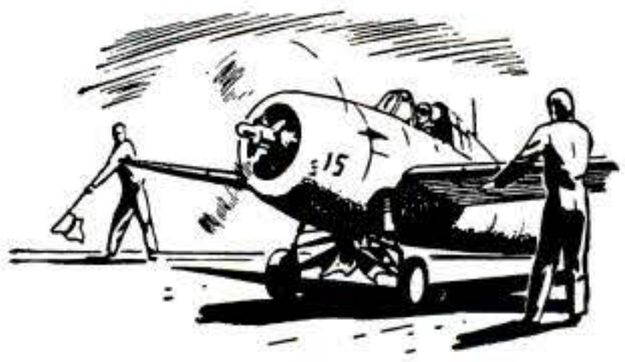
More Power in Cyclones on Deck *than in* Carrier's Turbines Below!



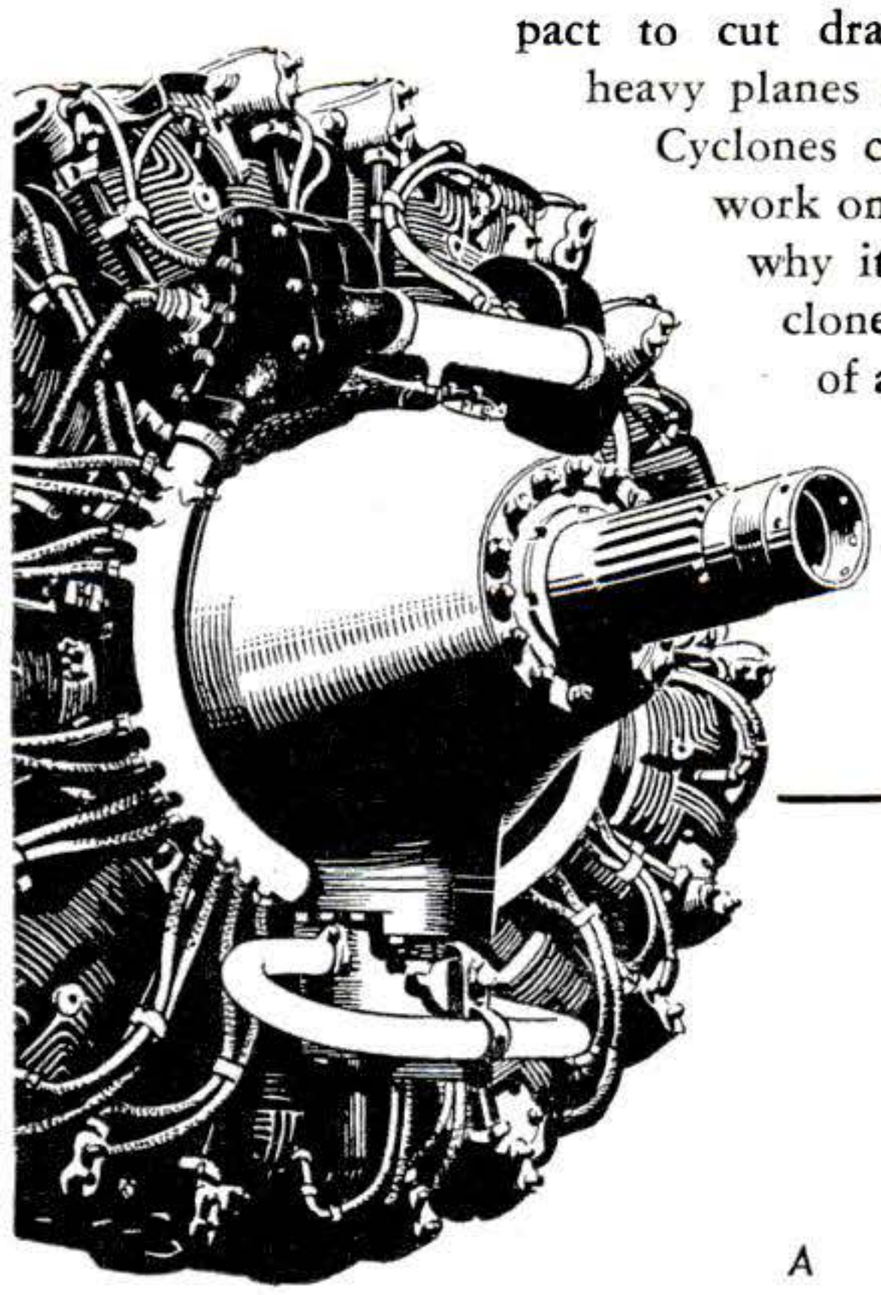
Surging into the wind at 30 knots, this 20,000-ton carrier is driven by massive turbines which can turn up more than 100,000 horsepower. On deck, there's a 1,700 HP Wright Cyclone in each Curtiss Helldiver and Grumman Avenger. Mighty as the carrier is, a normal number of these single-engined planes aboard may total 50,000 more horsepower in combined form than the turbines below.

Weight, size and power are the three critical points of an aircraft engine. It must be light to permit flight, compact to cut drag, powerful to carry heavy planes at high speed. Wright Cyclones come from 25 years of work on such problems. That's why it takes such a few Cyclones to equal the power of a carrier.



LIGHTEST: The Cyclone 9 of 1,350 HP in new FM-2 Wildcat is first service engine under a pound per HP. It weighs only 0.97 lbs. per HP.

TOUGH: A Cyclone 9 in a Douglas SBD-3, with oil line and 4 of 9 cylinders shot out of action, kept right on running to bring pilot and plane safely home.



Write for "ENGINOLOGY"

a 60-page booklet on the whys of engines

A complete, non-technical booklet on engines, propellers, and aircraft. Describes operating principles of engines and planes. Explains combustion, supercharging, ignition, carburetion. Just send twenty-five cents in stamps or coins to: Wright Aeronautical Corporation, Dept. *P.S.*, Paterson 3, New Jersey.

WRIGHT

AIRCRAFT ENGINES

A DIVISION OF CURTISS-WRIGHT CORPORATION

Buy War Savings Bonds and Stamps regularly.

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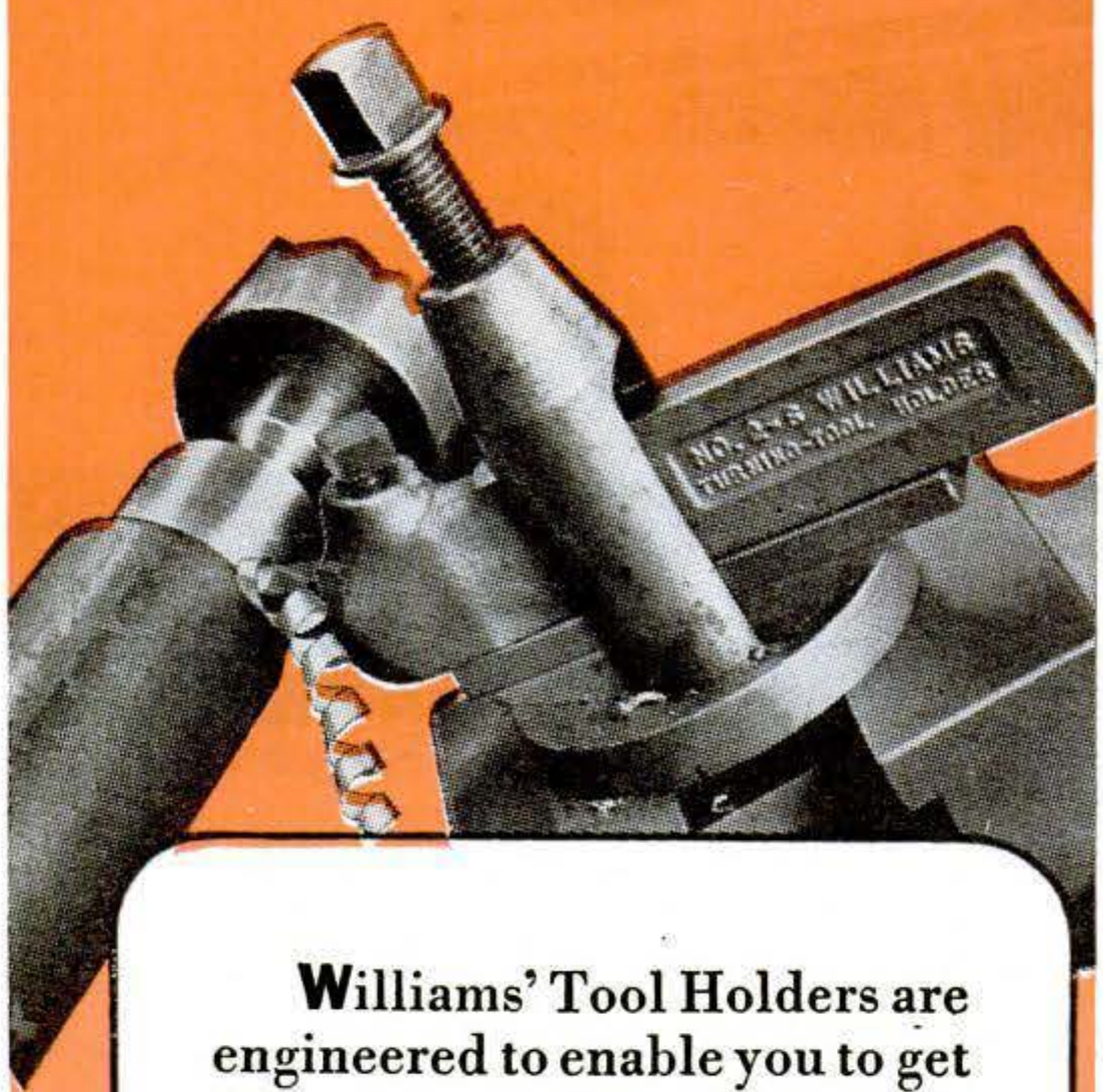
FOR IMPROVED LATHE PERFORMANCE



Williams' Tool Holders are engineered to enable you to get from the machine all that the builder built into it. There's a type for every regular operation of lathe, planer and shaper ... many incorporating design advantages found in no other holders.

Compare the performance you get with Williams' Tool Holders. Meanwhile, write Dept. S-2 for your free copy of Williams' Tool Holder Data Sheets, loaded with helpful information on grinding, set-up and use of cutting tools.

J. H. WILLIAMS & CO.
BUFFALO 7, N. Y.

DROP FORGINGS AND DROP-FORGED TOOLS

Railroads Hit the Beach

(Continued from page 83)

The MRS is patterned strictly on orthodox railroad organizations. The basic unit is the Railway Operating Battalion, made up of four companies. Each has its duties: dispatching and supplies, track and signal maintenance and maintenance of way, roundhouse operation and equipment repair, and the actual operation of the trains. A battalion runs a division of about 100 miles.

Three or four Railway Operating Battalions, together with a Railway Shop Battalion, a Base Depot Company and a Mobile Railway Workshop, make up a typical grand division. That corresponds in scope and authority to a general superintendent's domain on an American railroad.

Maj. Gen. Charles P. Gross, chief of transportation, is responsible for the MRS. Brig. Gen. Andrew F. McIntyre, formerly of the Pennsylvania, handles details at home.

A lack of standardization complicates the job. Clearances are the bane of the car and locomotive designer's pencil. Even in peacetime clearances lead to some fantastic routings. Any oversize shipment—one with considerable "overhang," projecting beyond a car's head-on silhouette—bound from New York to Washington, for instance, has to travel by way of Harper's Ferry, Va. There are some tunnels on the direct route that it won't clear.

In manufacturing for the Russians, American car and locomotive makers had few prohibitions. The average width of rolling stock in the United States is 10 feet, 8 inches; its height from the top of the rail, 15 feet. Russian stock runs to widths of more than 12 feet and heights of more than 17. In England, the width averages only 9 feet and the height less than 13.

Cars and locomotives for England had to be equipped with the exact opposite of the

(Continued on page 224)

Actual Size V-Plug

Model Builders Attention!

	V	V-2	V-3
Hex	1/2"	3/8"	5/16"
Thread	3/8"-24	1/4"-32	1/4"-32
Thread Length	7/32	7/32	5/32
Weight, Grams	8	3 1/2	2 1/2

Champion spark plugs for model gas engines give the same dependable performance as regular Champions. Sillment sealed. Sillimanite insulator. Alloy needlepoint electrodes for easy starting. One piece construction.

CHAMPION
SPARK PLUG COMPANY • TOLEDO 1, OHIO

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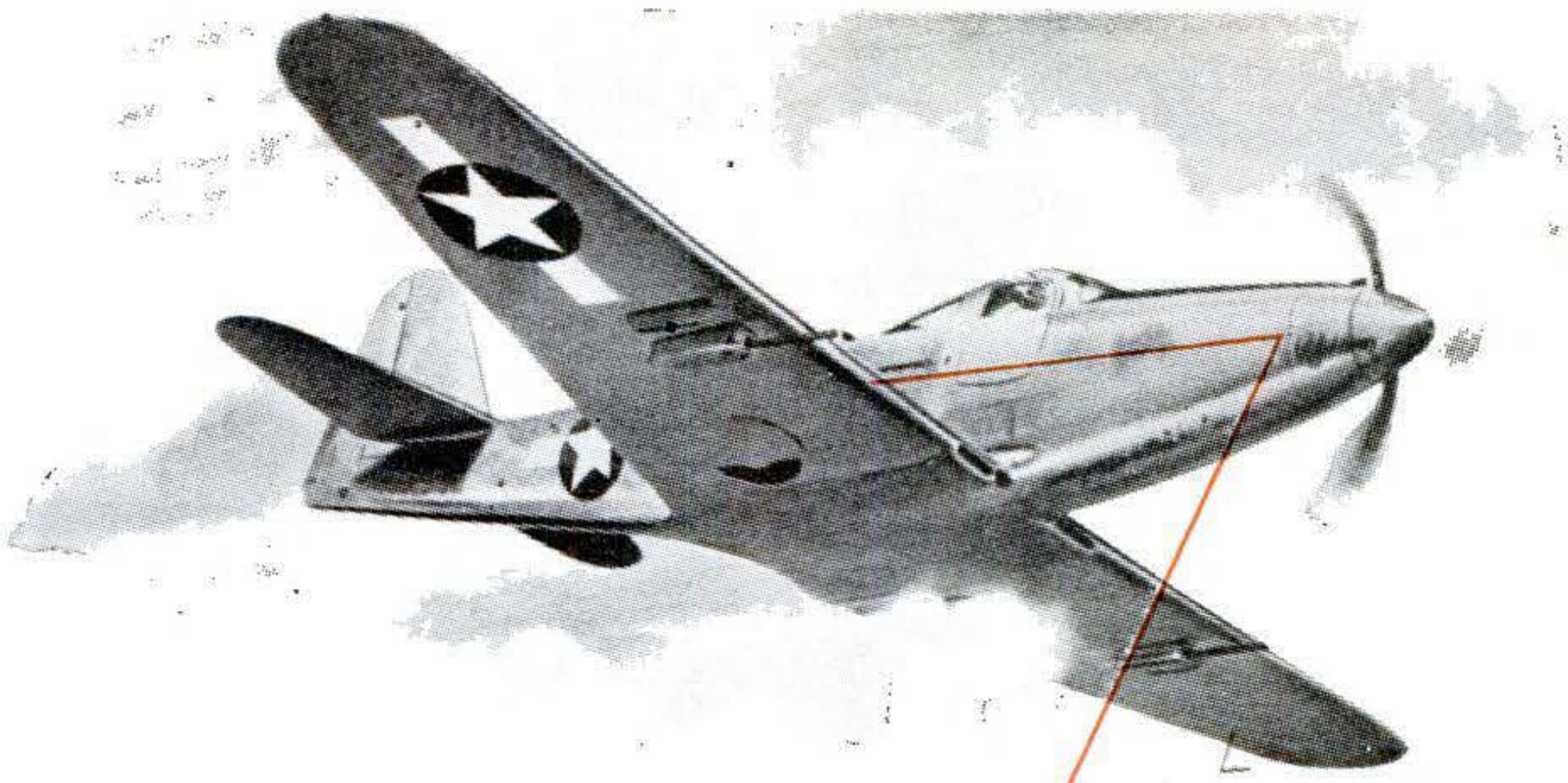

FROM THE STRATOSPHERE . . . BETTER SPARK PLUGS

FOR YOUR CAR!

For more than four years past, Champion Ceramic Aircraft Spark Plugs have been on active duty with our air forces, setting new records for long life and dependability. Extreme altitudes, extreme temperatures, 100 octane gas, and supercharging required new and revolutionary spark plugs, embodying materials and precision craftsmanship of an exceptionally high order. Today those same basic materials, fundamental design and exceptionally high manufacturing standards are yours, in Champion Spark Plugs, for your present car. Champions bring an extra measure of dependability to every engine. Champion Spark Plug Company, Toledo 1, Ohio.

DEPENDABLE

CHAMPION

SPARK PLUGS

ARMY E NAVY

Buy War Bonds
More Than Before

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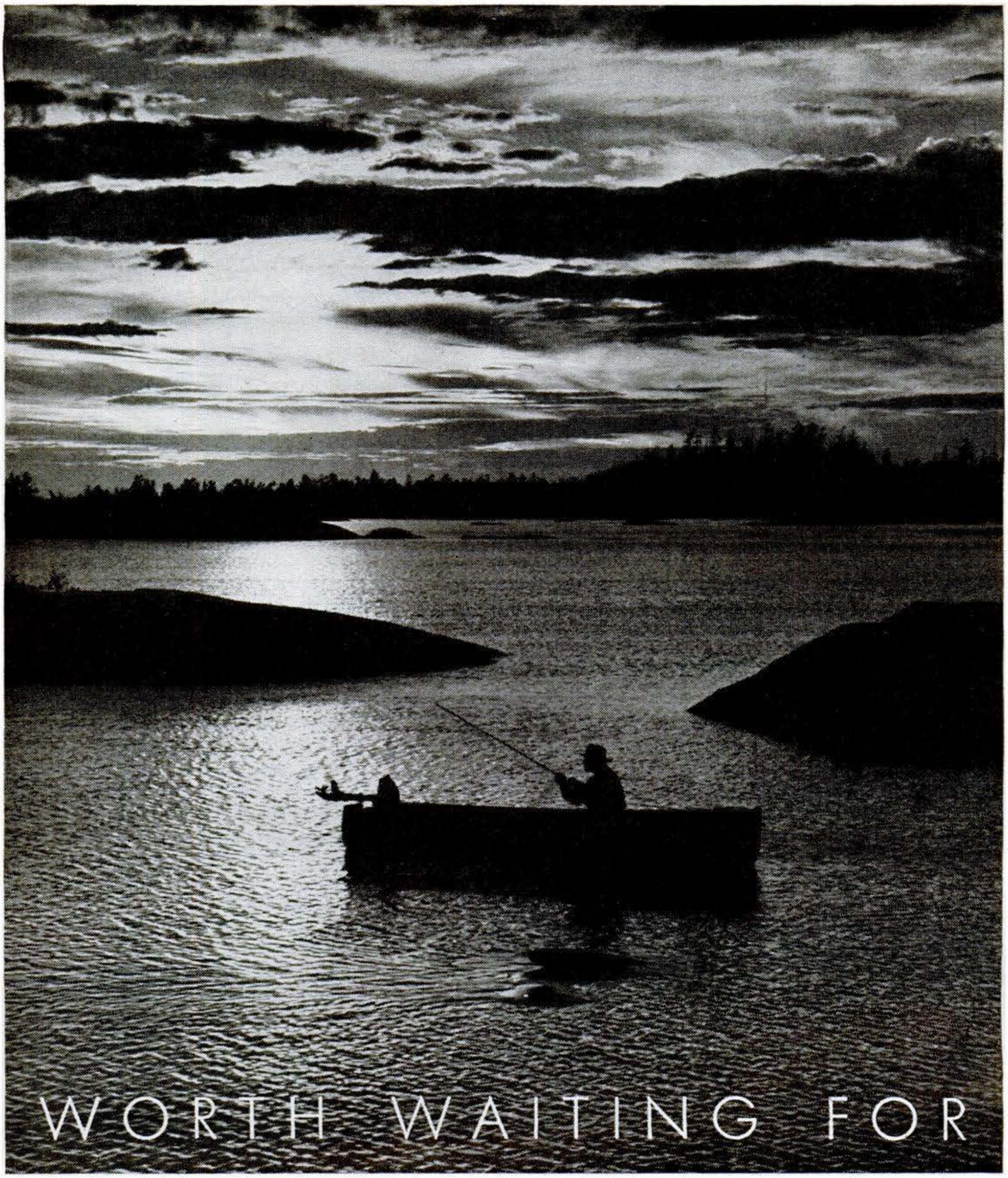

FISHING'S more fun than fighting . . . as twelve million fighting Americans will fervently agree. *Keeping on* producing everything *they* need is all that counts today. That is why the Evinrude you want for happy peacetime use may not be ready as quickly as you, and we, would like. All we can promise is . . . it will be *worth waiting for!* Evinrude Motors, Milwaukee, Wis.

EVINRUDE

ARMY E NAVY

OUTBOARD MOTORS

SPEED THE DAY . . . FOR THEM — FOR YOU . . . BUY MORE WAR BONDS

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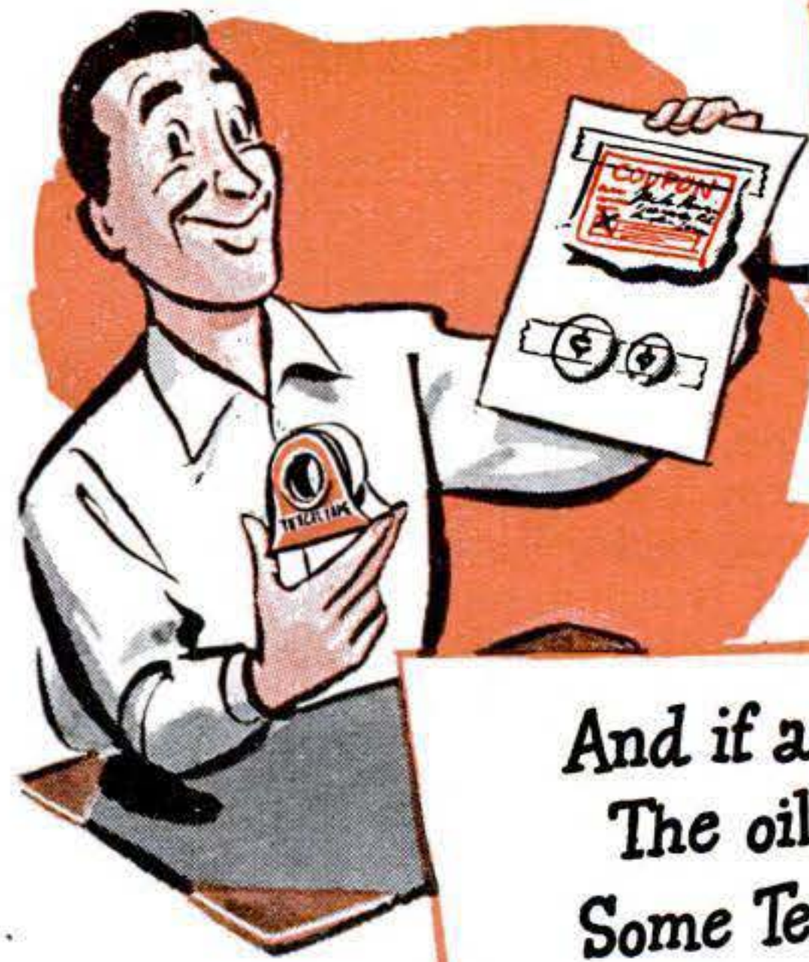
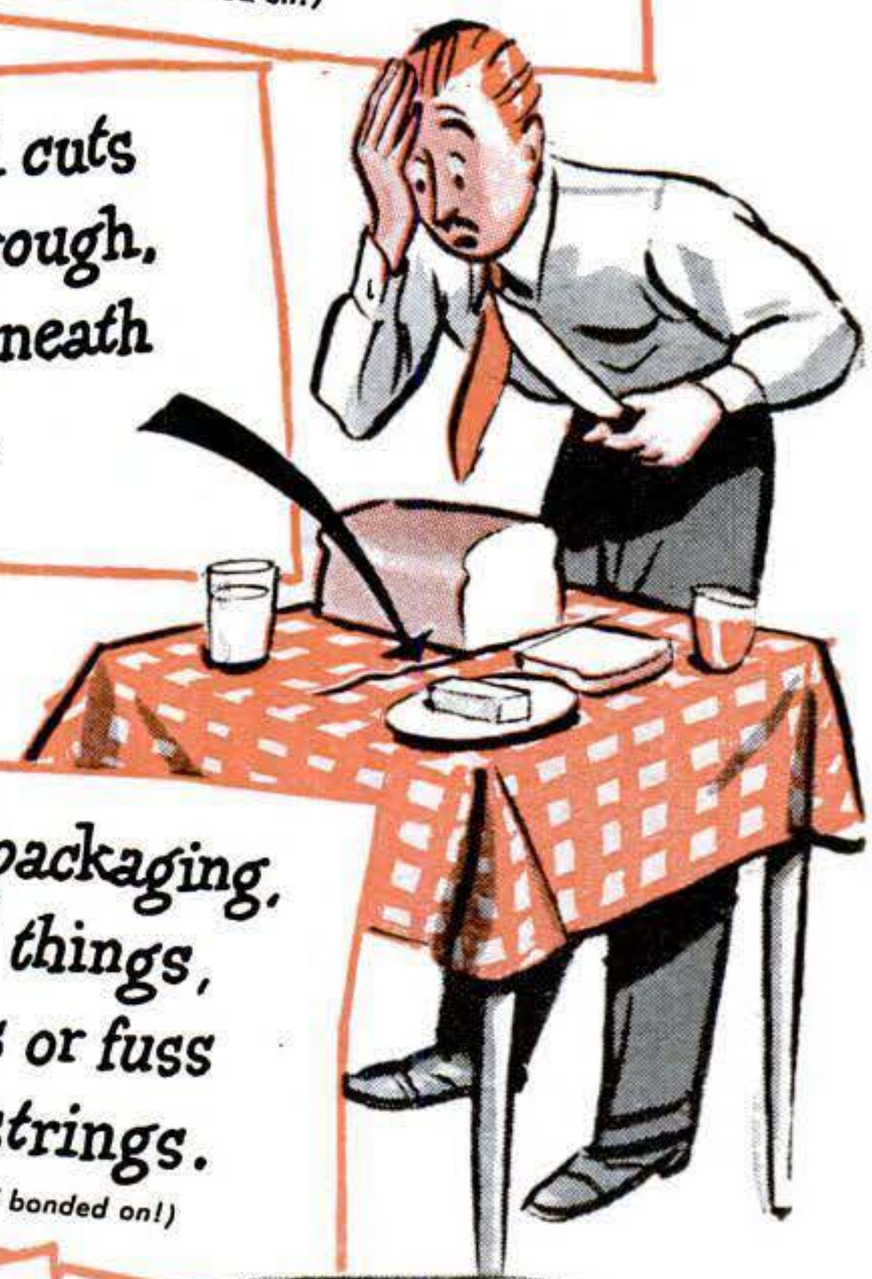


When sending small coins thru the mails
For samples, books and such,
Use Texcel Tape to hold them fast-
It sticks with just a touch.

(Texcel holds and holds—the "stick-um's" bonded on!)



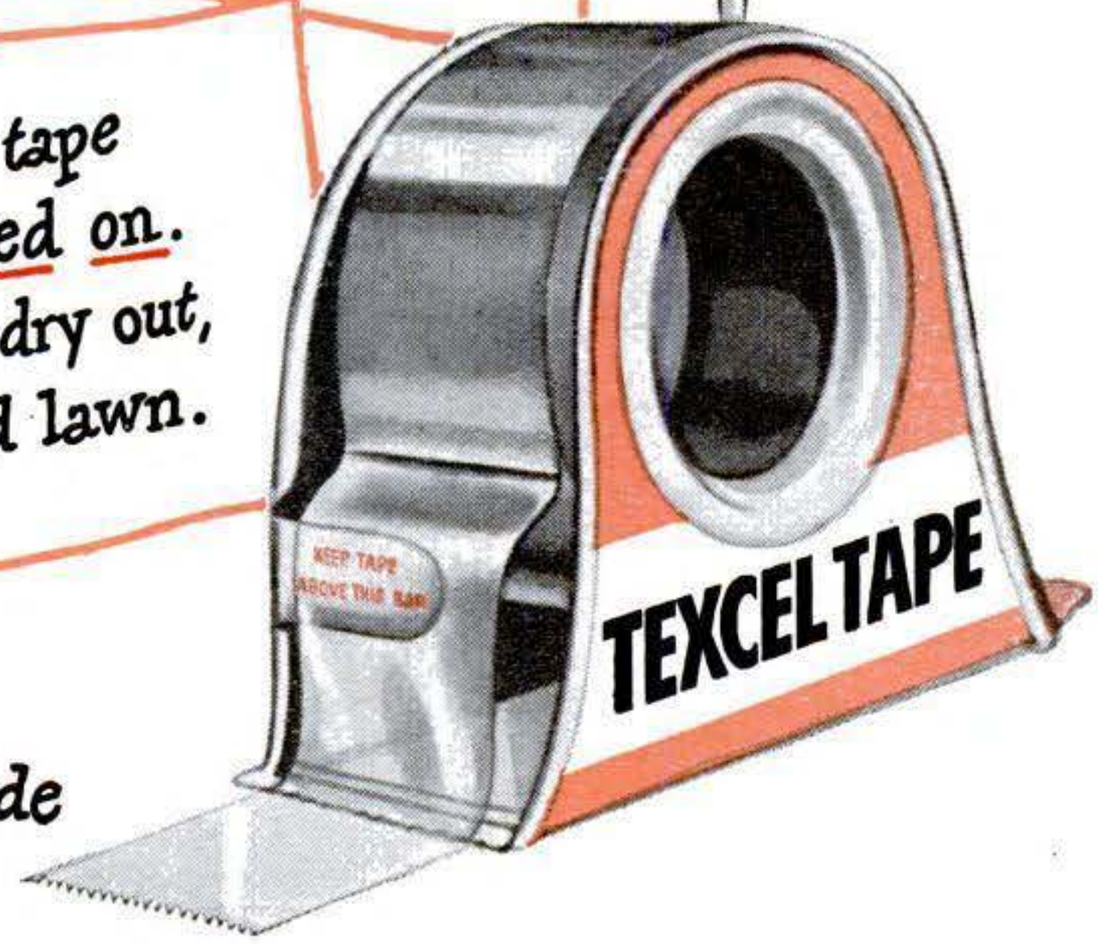
And if a sharp knife slips and cuts
The oilcloth through and through,
Some Texcel Tape stuck underneath
Will make it look like new.

(Texcel mends securely—the "stick-um's" bonded on!)

For bundling checks, for packaging,
For holding scores of things,
Use Texcel Tape - no muss or fuss
With glue or bits of strings.

(Texcel means no gummy edges—the "stick-um's" bonded on!)

Yes, Texcel is an improved tape
Whose "stick-um's" bonded on.
It won't come off, it won't dry out,
It's one, like grass and lawn.



Today most Texcel Tape that's made
Is being used for war.
Buy Bonds and Stamps 'til Victory
Returns it to your store.

Made by
Industrial Tape Corporation
A Division of
Johnson & Johnson
New Brunswick, N.J.

Texcel Tape

REG. U. S. PAT. OFF.

'CELLOPHANE TAPE — STICKS WITH A TOUCH

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MORE POWER TO IT!

P. R. MALLORY & CO. Inc.

MALLORY

Tropical*

DRY

BATTERIES

Originally developed by Mallory for the United States Army Signal Corps.

Today war needs claim our output. Tomorrow civilians may expect great things from this fundamentally different battery.

P. R. MALLORY & CO., Inc.

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P. R. MALLORY & CO. Inc.

MALLORY

Railroads Hit the Beach

(Continued from page 220)

American braking system. Over here compressed air is used to keep the brake shoe off the wheel; when the air is released the brake clamps on. In England a vacuum in the air line sucks the shoe onto the wheel.

American manufacturers discovered they had to take the Russian temperament into account in filling lend-lease orders. Spare wheels had to be shipped by the thousands. When a Russian locomotive engineer comes to a grade and claps on the brakes, he takes no half measures.

They discovered they had to equip locomotives intended for India with extra-brilliant headlights. That was so the engineers could see the sacred cows, wild elephants, and human foot traffic on the right of way.

There was the field problem of increasing the traffic on Indian railroads to deliver supplies to the Ledo Road truck route and to the airfields used by planes flying "the Hump." The Bengal and Assam Railway had twin gauges, extra wide and narrow. It wound north from Calcutta for 800 miles, and then all the supplies had to be transshipped on to meter gauge for almost 1,000 miles more.

For 31 of the last 32 years the narrow gauge had been inoperative for as much as six months of the year when rivers boiled out of their banks. U. S. railroad men rechanneled the rivers and built a bridge as a substitute for the car ferries traditionally used for the crossing of the mile-wide Brahmaputra River. Where three or four trains a day ran before the war, from 21 to 25 are now operating with 12,000 wagons and 550 locomotives of the 2-8-2 type, marked "Made in U. S. A."

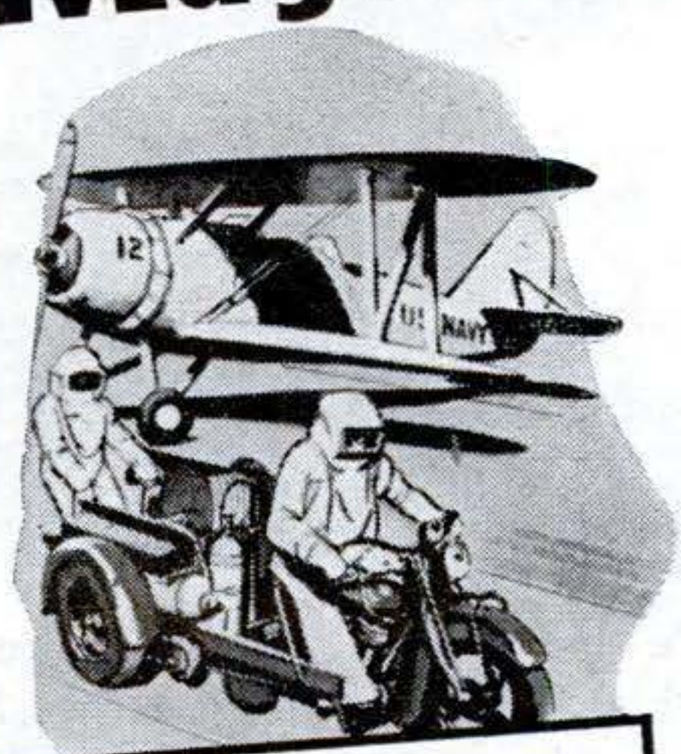
The MRS has had its compensations. When it landed behind the assault troops in North Africa, what should meet its delighted eye but a score of "General Pershing" locomotives that the United States shipped to France for World War I. They were as good as ever.

German railroads, with 44,000 miles of standard gauge, present no great problem to the Army. Nor will the railroads of China and Japan. In row upon row of secret files in Washington's sprawling Pentagon Building are details on Japanese and Chinese railroads.

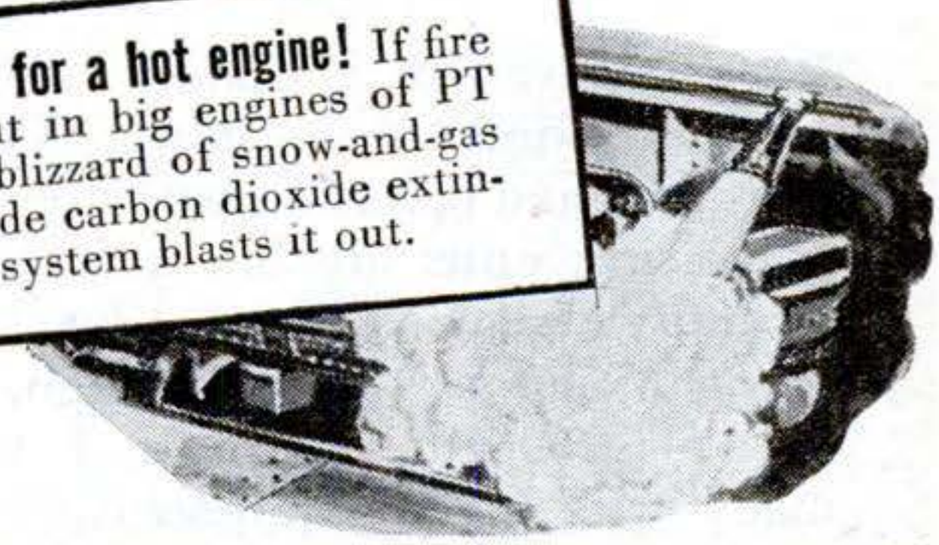
The Military Railway Service of the Army's Transportation Corps has only one problem it hasn't solved. It would like to know how to keep monkeys from swarming into passenger carriages when trains stop at stations in India.

Magic bottle rescues flyer!

Gas-under-pressure is stored in small Kidde cylinders on rubber rafts that keep our forced-down flyers afloat. Pilot turns a valve and gas expands *450 times*, pouring life-saving buoyancy into raft in three seconds. This is carbon dioxide—the gas that puts "fizz" in soda pop!



Motor-bike built for two—firemen! Naval airports kill fire *fast*, with Kidde carbon dioxide extinguishers rushed by motorcycle "crash trucks" to scene of fire.



Snow-bath for a hot engine! If fire breaks out in big engines of PT Boats, a blizzard of snow-and-gas from Kidde carbon dioxide extinguishing system blasts it out.

Gases-under-pressure, harnessed by Walter Kidde & Company, are serving our fighting men in many ingenious ways. After the war they'll serve you. Look for them!

Walter Kidde & Co., Inc., 140 Cedar St., N. Y. 6, N. Y.

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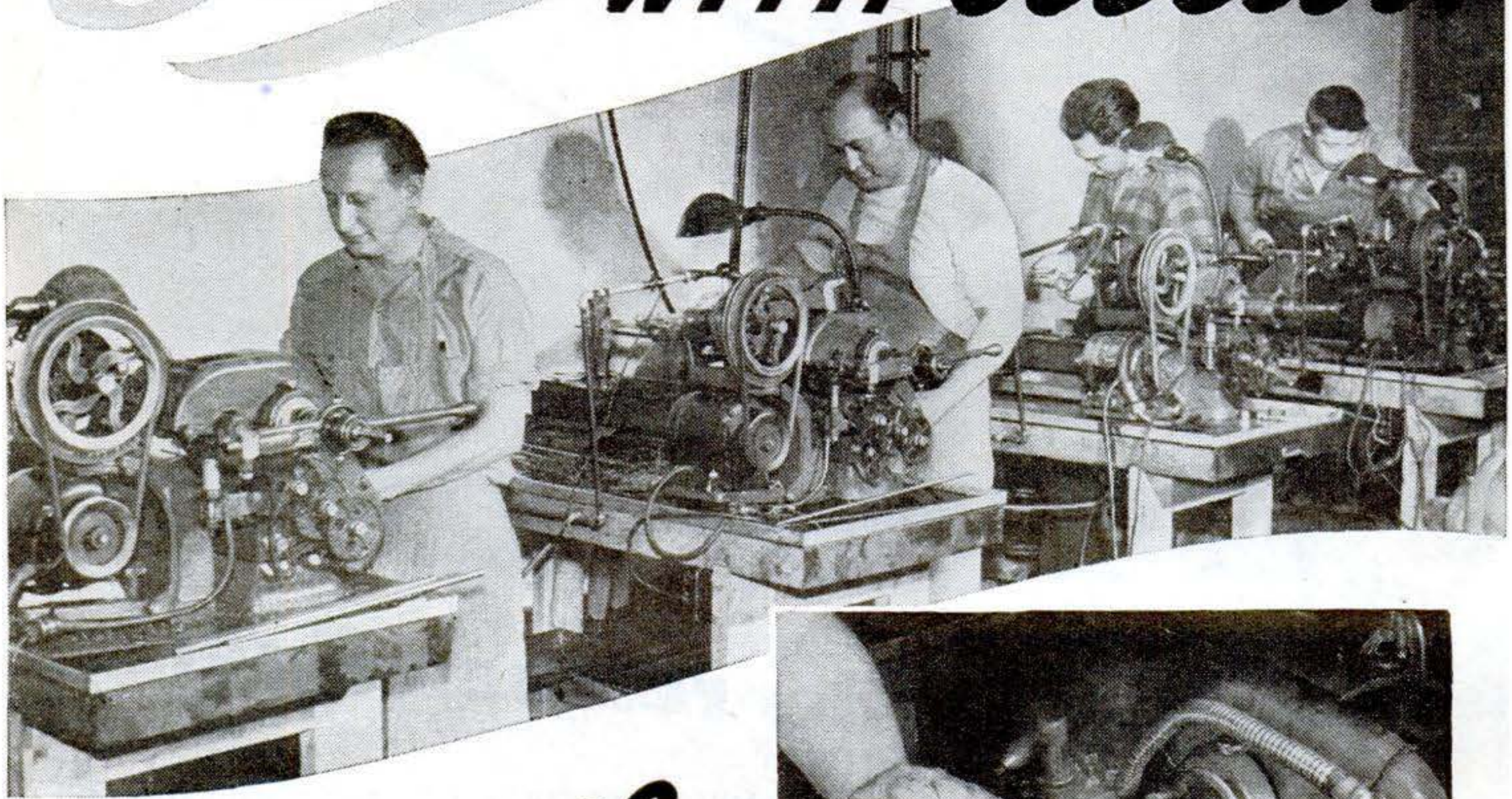
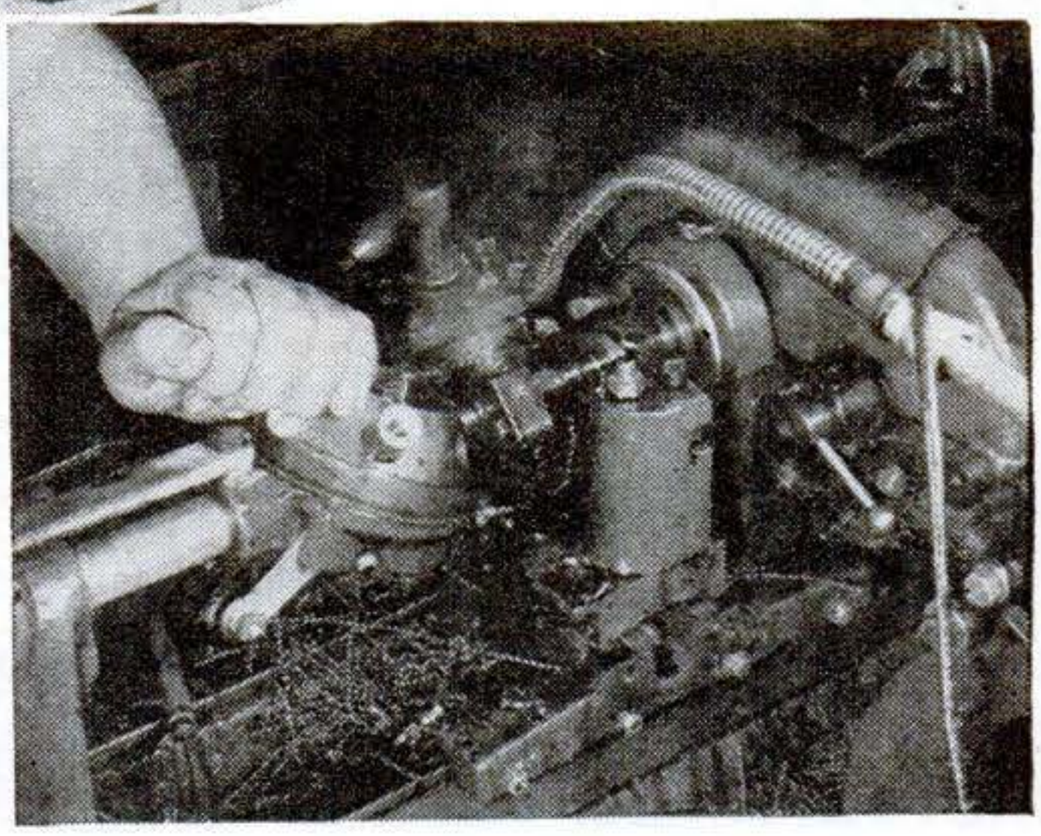
Salute WITH Atlas





OVER 500,000 VITAL WAR PARTS FROM PLANT STARTED WITH ONE ATLAS LATHE

Poppit Valves for hydraulic controls in Mitchell Bombers and North American Mustangs and precision parts for oxygen regulating units are but a few of the 98 individual jobs handled by the Precision Machine Works, Chicago, where over 500,000 vital war parts have been made with Atlas equipment.

"Our shop started with a single Atlas lathe shortly after Pearl Harbor," reports Mr. L. W. Skuse, Pres. and Treas. "Since that time we have purchased about 26 lathes and 9 drill presses from you. We have used your lathes as straight bench lathes, turret lathes, hand screw machines and have machined practically all types of material."

America always has been — and will be in the busy postwar days — a land of opportunity for men with vision and courage and mechanical ability. If you have thought of and planned for a shop of your own for commercial or personal use, you can build it soundly with Atlas lathes, drill presses, milling machines, and shapers. Send for latest catalogs.

ATLAS PRESS COMPANY
243 N. PITCHER ST., KALAMAZOO 13D, MICHIGAN

NEW ATLAS PATTERN SERVICE FOR WOOD CRAFTSMEN — See ad on page 236

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Another great day in railroading was heralded in January, 1888, when the Atlantic Coast Line ran the first de luxe vestibule Pullman train from New York to Jacksonville, Florida.

IT'S A GREAT NEW DAY FOR RAILROADING

Today powerful GM Diesel locomotives on the Atlantic Coast Line whisk Florida's fresh fruits and vegetables to major American markets in a matter of hours. This is possible because these locomotives haul heavy trains faster and stay on their job longer with few stops for service.

ONE thing is certain—Americans will have an entirely new level of transportation, postwar. Two factors will make this inevitable:

The amazing achievements of the railroads under the stress of war.

The new and exciting prewar records for rapidity, regularity of service, safety and comfort the railroads had established with General Motors locomotives.

American railroads are in a favored position to lead in this fine new service because a most vital tool which makes it possible is fully developed and thoroughly proved. Already General Motors Diesel passenger and freight locomotives are operating on more than 100 million miles, annually, of regularly scheduled service. Yes, it's a great new day for railroading—with even greater days ahead.

ON TO FINAL VICTORY BUY MORE WAR BONDS

GM GENERAL MOTORS DIESEL POWER

LOCOMOTIVES . . . . . **ELECTRO-MOTIVE DIVISION,** La Grange, Ill.

ENGINES . . 150 to 2000 H.P. . . CLEVELAND DIESEL ENGINE DIVISION, Cleveland 11, Ohio

ENGINES . . . 15 to 250 H.P. . . . . DETROIT DIESEL ENGINE DIVISION, Detroit 23, Mich.

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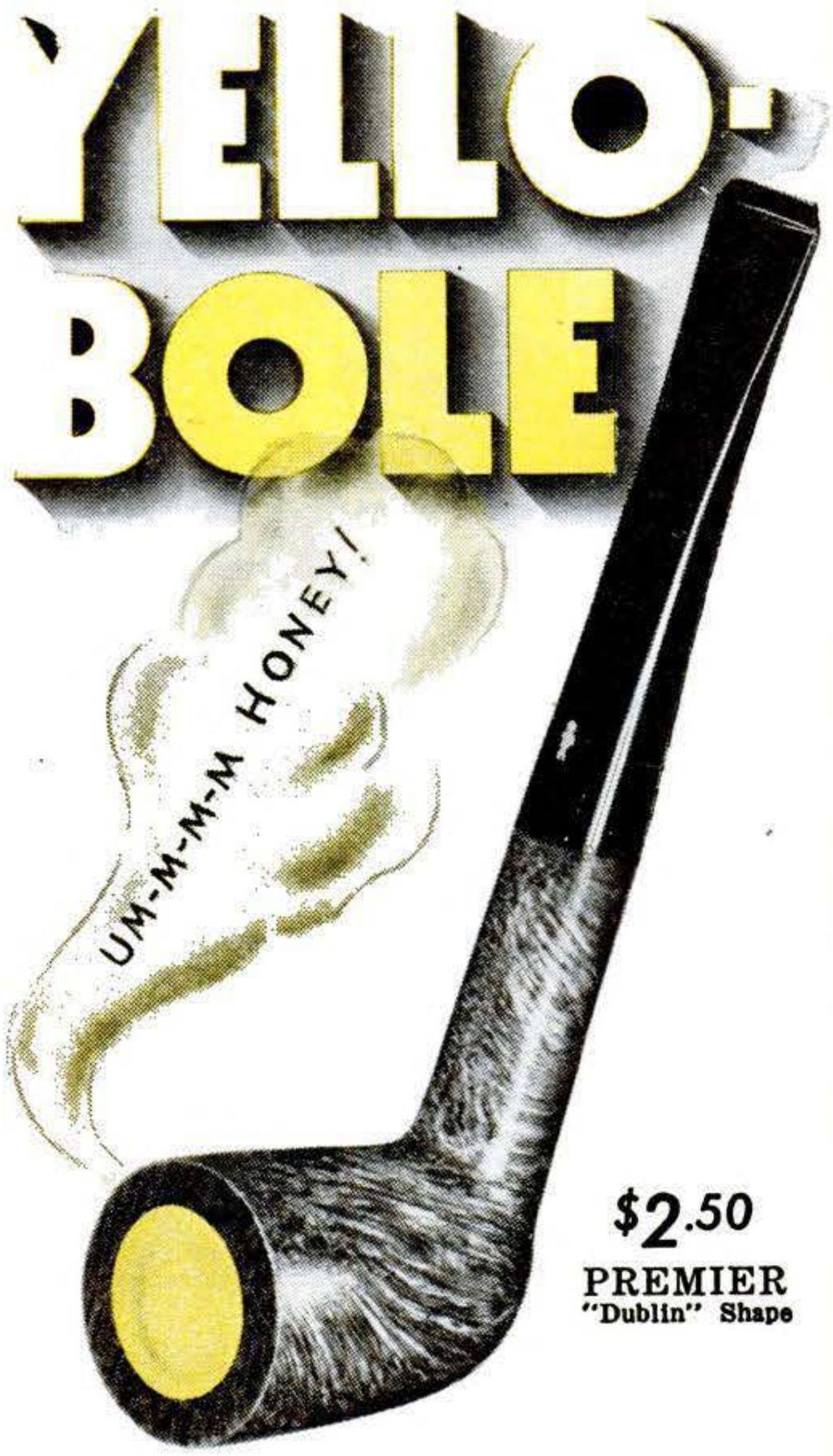

HONEY

cures your smoke

Honey is sprayed and brushed into Yello-Bole Pipes. It blends gently with the tobacco—so that the pleasant, mild flavor of it joins with the tobacco-flavor and aroma, forming the most enjoyable, satisfying smoke ever imagined in the most wishful hopes for "the perfect" pipe smoke. You don't have to get used to a Yello-Bole. You'll find it enjoyable from the start. Army and Navy needs come first of course—but your dealer is being supplied.

YELLO-BOLE PREMIER $2.50
YELLO-BOLE IMPERIAL $1.50
YELLO-BOLE STANDARD $1

YELLO-BOLE A NAME TO REMEMBER, WHEREVER YOU ARE—AND WHEN YOU COME HOME

Japan's "Mystery Ships"

(Continued from page 96)

They never got there, because they had given us enough time to reorganize a fighting fleet powerful enough to hurl them back with smashing losses in the Battle of Midway. Later, when our own amphibious forces seized the offensive in the Solomon Islands, Nipponese warships staged a whole series of attacks in gradually increasing strength. Why they failed to use their full power at first can be explained only by the inscrutable Oriental mind; as it was, we were able to reinforce our embattled fleet rapidly enough to repel every onslaught.

From that time until last October the constant question was, "What will make the Jap fleet come out and fight?" The answer came when MacArthur invaded the Philippines, with the obvious objective of taking Manila and its strategic naval base astride Japan's life lines to her southern conquests. And the result was the Second Battle of the Philippines—actually three battles in one—where mighty battleships slugged it out with shells in the rare and awesome spectacle of a full-dress fleet action.

It was a desperate gamble, since it committed virtually all of Japan's warships, but a better move than to wait until growing Allied seapower sealed the gates of the Empire. From southern Asia outposts, a pair of Jap fleets sought to thread the two main passages through the Philippines and meet in a pincers movement, where MacArthur's supposedly vulnerable invasion craft were unloading reinforcements and supplies on the island of Leyte. Meanwhile, a third Jap fleet approaching from the north would provide support. If complete surprise could be obtained, so much the better.

Wary of just such a move, however, Vice Admiral Thomas C. Kinkaid had posted U. S. submarines as lookouts on the western side of the Philippines, meanwhile guarding MacArthur with his 7th U. S. Fleet of battleships and lighter craft—supplemented by Australian cruisers and destroyers. Promptly the subs detected the invaders and flashed him warnings. Shortly after, a scouting plane sighted the Jap fleet from the north, and relayed a message to Admiral William F. Halsey's U. S. Third Fleet of fast battleships and carriers, roving farther to sea.

Cramming on speed, Halsey sped north and intercepted the surprised Japs at dawn. Before they knew what had hit them, their four carriers were sunk—and the rest of the ships, many damaged, turned tail. Reluctantly abandoning pursuit, Halsey dashed

(Continued on page 232)

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Fast Becoming
AMERICA'S NEW FAVORITE

Make a Date with GOOD TASTE

Wherever you're going, there's Good Taste waiting in the smooth, mellow goodness of Blatz.

It's a beer to seek . . . one to enjoy . . . one to remember—with pleasure.

Try this finer beer that's never sharp...never bitter...always ripe and ready. Whenever you want enjoyment, it's a date!

Blatz Brewing Co., Milwaukee, Wis. • *In our 94th year*

MILWAUKEE'S MOST EXQUISITE BEER

Buy MORE War Bonds

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QUALITY . . . WORTH WAITING FOR

THERE WILL BE A SLIGHT PAUSE . . .

One of these days, restrictions will be lifted on outboard motor sales for pleasure use.

While Johnson has the facilities to build a major share of all outboard motors manufactured, there will definitely be some lag between the lifting of restrictions and full deliveries of all Sea-Horse models.

How long? That depends on many things, including army and navy requirements. There has been, there still is and there will be a large army and navy demand for ***Sea-Horses.***

The qualities that make Sea-Horses suitable for war—ruggedness, smooth performance, and DEPENDability — are qualities worth waiting for. To get these qualities, you may have to wait a while after restrictions are lifted; but you'll have them for YEARS of satisfaction thereafter.

DEALERSHIPS: If you are interested in selling AND SERVICING outboard motors after the war, write us now—no matter what your location may be.
JOHNSON MOTORS, WAUKEGAN, ILLINOIS

THERE IS NO SUBSTITUTE FOR EXPERIENCE

DO YOUR DUTY — ARMY E NAVY — BUY WAR BONDS

JOHNSON SEA-HORSES for DEPENDABILITY

Big Demand for Wood! Prices Never as High!
QUICK PROFITS with OTTAWA

Log Saw of the Future TODAY!

OTTAWA 6 H-P LOG SAW

FELLS TREES • SAWS LOGS
Buzzes Up Poles and Limbs

Unbeatable combination! 3 in 1 machine. Does everything you need fast and easy. You can turn wood lot into cash quickly and profit by present high prices.

USE ENGINE FOR BELT JOBS—When not sawing wood, use the engine to grind feed, pump water, etc. Pulley furnished.

THOUSANDS IN USE EVERYWHERE

Speed Up Production!
Thousands NOW making more money with an OTTAWA LOG SAW. You can beat the labor shortage with this powerful machine. Saws the human way, only many times faster. Starts easy in any weather.

350 Saw Strokes per Minute
Air cooled motor—a blessing in winter. No shut-downs or strikes. Many exclusive OTTAWA features. Uncle Sam needs you to help relieve the nation wide fuel shortage. No priority needed when you buy an OTTAWA. Plan to get yours at once!

What Users Say "My 6 H-P Ottawa is a mighty magnet of power and energy. It is always ready to work in any kind of weather and makes log sawing a pleasure. It is easy to operate profitably and economically."—*Edward Androus, California.*

FREE Big Catalog Write today for your FREE copy of the Ottawa Catalog. Contains complete information of the "6" and other Ottawa Saws.

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New Thousands Now Wear a Hearing Aid

Thanks to the

NEW ZENITH *NEUTRAL-COLOR* EARPHONE and CORD

...Have you tried Its New "Look of Youth" on You?

ANOTHER great Zenith advancement is encouraging *new thousands* to discover the blessings of a hearing aid!

The Zenith Radionic Hearing Aid brought the *cost* of better hearing within reach of all. Now the new Neutral-Color Earphone and Cord brings a new standard of *smart appearance* that enables you to wear a hearing aid with poise and confidence.

This Zenith ensemble is actually *as little noticeable as eyeglasses!* Its streamlined, complexion-tinted plastic earphone is light in weight, comfortable. Its translucent plastic cord is perspiration-proof, fray-proof, kink-proof . . . gives less friction or clothing noise than any fabric-covered cord.

Ask the Zenith dispenser near you for a *free* demonstration of the smart looking, superbly performing Zenith. No obligation! Send coupon below.

Why Its Fine Quality Costs You So Little

If only a few Zeniths were made, each would cost many times more, yet have less precision quality—as Zenith proved when its precision mass production lowered the cost of a $200 radio to $29 and made it an *even finer* instrument. Now Zenith combines this production with a sales method which *eliminates* salesmen's huge commissions and other high sales costs . . . to bring you an *even finer* hearing aid than our original $50,000 model.

CANADIANS! The Zenith Radionic Hearing Aid (Air Conduction) with *Neutral-Color Earphone and Cord* is available in Canada—*direct by mail only*—at $40 (Canadian currency). No extra charge for shipping, duties, taxes! Write Dept. PS-15, Zenith Radio Corporation of Canada, Ltd., P. O. Box 30, Windsor, Ontario.

A New Zenith Model for Every Type of Correctable Hearing Loss

1 Model A-2-A. New improved model of the famous nationally popular standard Zenith for the person of average hearing loss. New, patented "Prentiss Tube" brings clarity and volume range with low battery consumption! Complete—ready to wear, only . . . **$40**

2 Model A-3-A. New Air Conduction Zenith . . . A brand new, *super-power* instrument with tremendous volume in reserve to assure maximum clarity and tone quality even under the most difficult conditions! This special model complete, ready to wear, only **$50**

3 Model B-3-A. New Bone-Conduction Zenith. A new, powerful precision instrument created specially for the very few who cannot be helped by any air conduction aid. Exclusive Zenith "Stator Mount" Headband automatically warns when headband pressure exceeds normal adjustment! Complete, ready to wear, only **$50**

NEW ZENITH RADIONIC HEARING AIDS

(All 3 models complete with Radionic Tubes, Crystal Microphone, Magnetic Receiver, Batteries and Battery Case)

BY THE MAKERS OF ZENITH •LONG DISTANCE• RADIO

RADIONIC PRODUCTS EXCLUSIVELY—WORLD'S LEADING MANUFACTURER

FREE! Illustrated Descriptive Literature
Gives complete information on advantages of the three new Zenith Radionic Hearing Aids. Mail coupon *now!*

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P. O. Box 6940A, Chicago 1, Illinois

Please send me *free* literature about Zenith Radionic Hearing Aids—together with name and address of nearest Zenith dispenser.

Name .....

Address .....

City ..... *State* .....

☐ Physicians check here for special literature.

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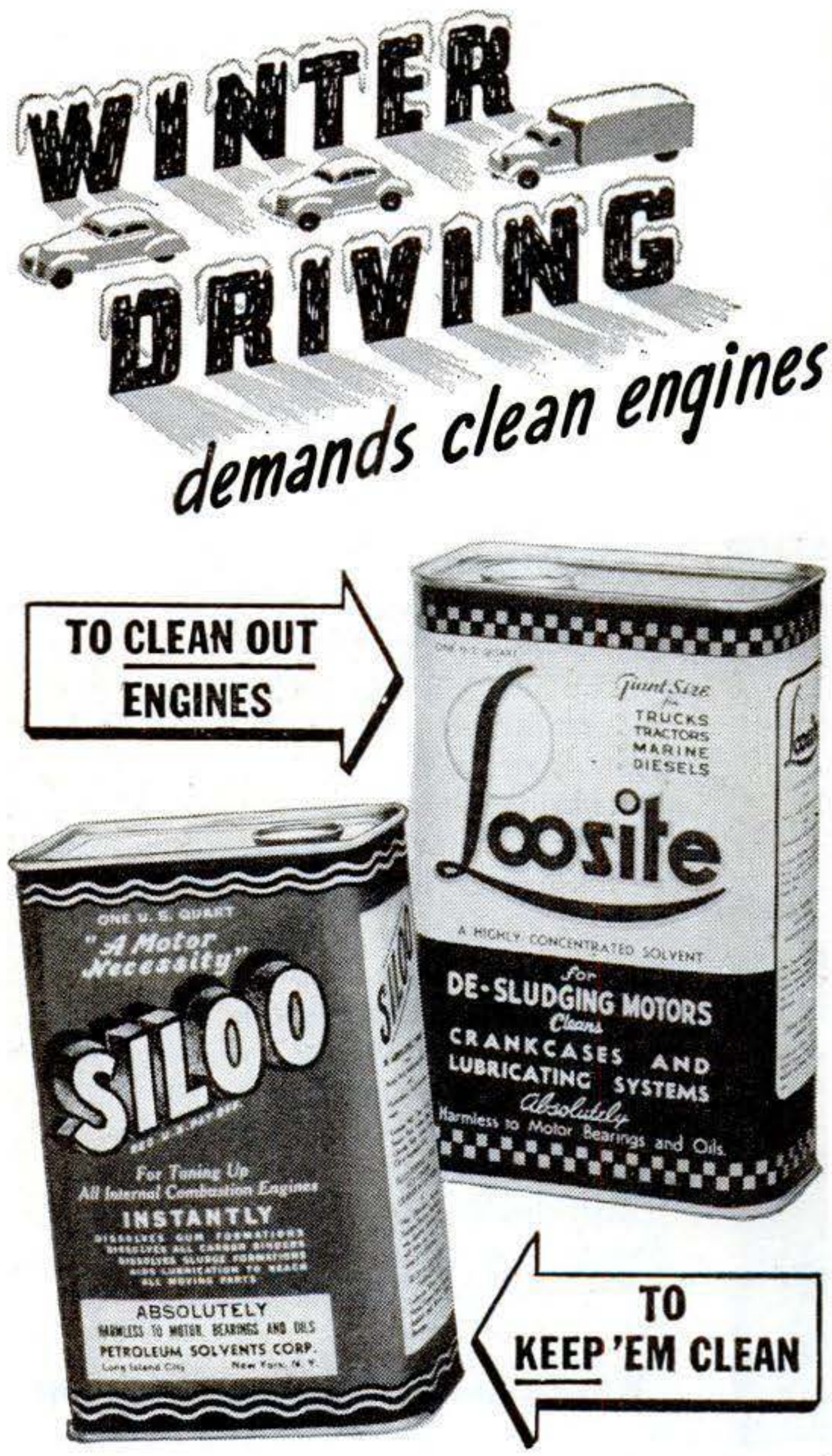

FREEZING weather brings many hazards to motors and their lubricating systems. Oil congeals and flows slowly—causes hard starting, battery drain and inadequate lubrication of vital parts...hence costly layups and repairs. Water—due to condensation—forms in gas tanks, creeps into fuel lines, carburetor and fuel pump ...causes stalled motors and other troubles.

Wise motorists forestall such hazards and—simultaneously—fight sludge, gum, acid and corrosion—*year round enemies to the long-life and efficient operation of motors*—with **LOOSITE** and **SILOO.**

Have your service station or dealer first *clean out* your motor with **LOOSITE**—quickly, safely, economically; then add **SILOO** to fresh crankcase oil...and to take care of moisture in the gas tank and fuel lines add **SILOO** to the gas tank. Reduced winter driving hazards will be your quick and lasting rewards.

Petroleum Solvents Corp.

General Offices: 331 Madison Ave., New York 17, N. Y.

P. S. *If you heat with oil—write for information on our Fuel Oil Tank Solvent.*

Japan's "Mystery Ships"

(Continued from page 228)

south again, in response to a report that the U. S. defenders of San Bernardino Strait were having their troubles with the central Japanese force.

And so they were. Baby flat-tops on watch in the channel found themselves confronted with an overwhelming Jap fleet, including two 45,000-ton battleships. Gallant U. S. destroyers braved mortal peril to lay a smoke screen behind which the light carriers retired—into a providential east wind that enabled them to launch their planes on the run. Circling back, the aircraft pounded the oncoming Japs with such fury that they made slow progress, although they overtook and destroyed a few light American craft. Forcing the passage into the Pacific, the Japs started toward Leyte—and then mysteriously turned back and fled the way they had come.

Evidently their commander, the Navy concludes, must have received word of the fate of the northern Jap force, and also of the southern Jap fleet which had sought to negotiate the Surigao Strait at night. Here Admiral Kinkaid had laid a neat trap of battleships and supporting forces.

Dark silhouettes of the Jap warcraft suddenly stood out against a fiery sky as PT boats, destroyers, and cruisers opened the engagement. Then, with a thunderous crash, the U. S. battleships spoke their piece. Their commander had accomplished an admiral's dream by crossing the enemy's "T," or steaming across the head of his adversary's battle line—which enabled him to bring all his guns to bear while only the forward guns of the enemy ships could reply. To make things perfect, the Japanese elected to escape by turning in column, or follow-the-leader fashion. The first ship gave the range, and practically every subsequent U. S. salvo crashed home. Save for a destroyer or two, every ship of the southern Jap contingent, including the battleships *Fuso* and *Yamashiro,* went to the bottom. In the triple engagement, these two battleships, four carriers, and six Jap cruisers were definitely seen to sink, while 13 other major warships were presumably knocked out of action for from one to six months.

Old scores were settled in that and nearby actions. Five battleships damaged at Pearl Harbor, refitted and as good as new, avenged themselves is the Surigao Strait affair—the *Pennsylvania, Maryland, Tennessee, California,* and *West Virginia.* One other battleship, the *Mississippi,* shared honors with them.

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The sun is rising on a new day, a new world

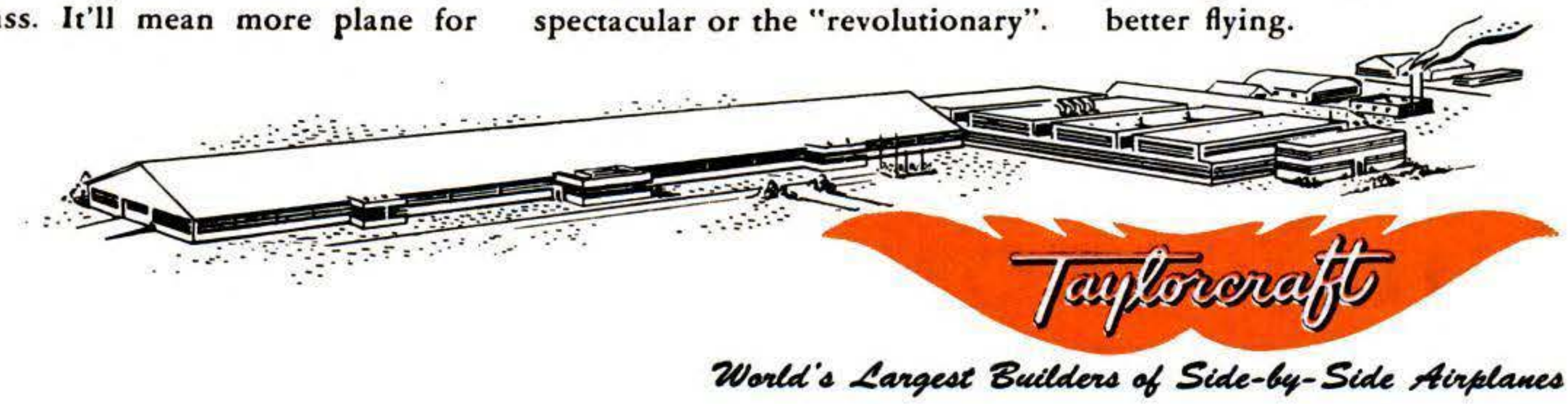
IT'S a day and a world already accepted in the minds of the American people—a world of man-made flight.

We may not see it this month or this year. But it will come. And when it does the name Taylorcraft will mean just what it means now—just what it has meant for many years . . . the best, the safest, the most dependable airplane in its class. It'll mean more plane for your money, finer performance, greater stability, longer cruising range, more genuine owner satisfaction and enjoyment.

Prototypes of new 'Crafts are already in the air. Are they revolutionary? The answer is "NO". Sure, great improvements have been made. But at no point has Taylorcraft performance and dependability been sacrificed merely for the sake of the spectacular or the "revolutionary".

That's why all of us—owners, instructors, fixed base operators—know that we can look forward to this new day with confidence, assurance, and a very real sense of satisfaction.

That's why all of us—private pilots, distributors, dealers—should keep our eyes on Taylorcraft. "The ship with the built-in tailwind" is coming our way, with more and better flying.



World's Largest Builders of Side-by-Side Airplanes

TAYLORCRAFT AVIATION CORPORATION · ALLIANCE, OHIO

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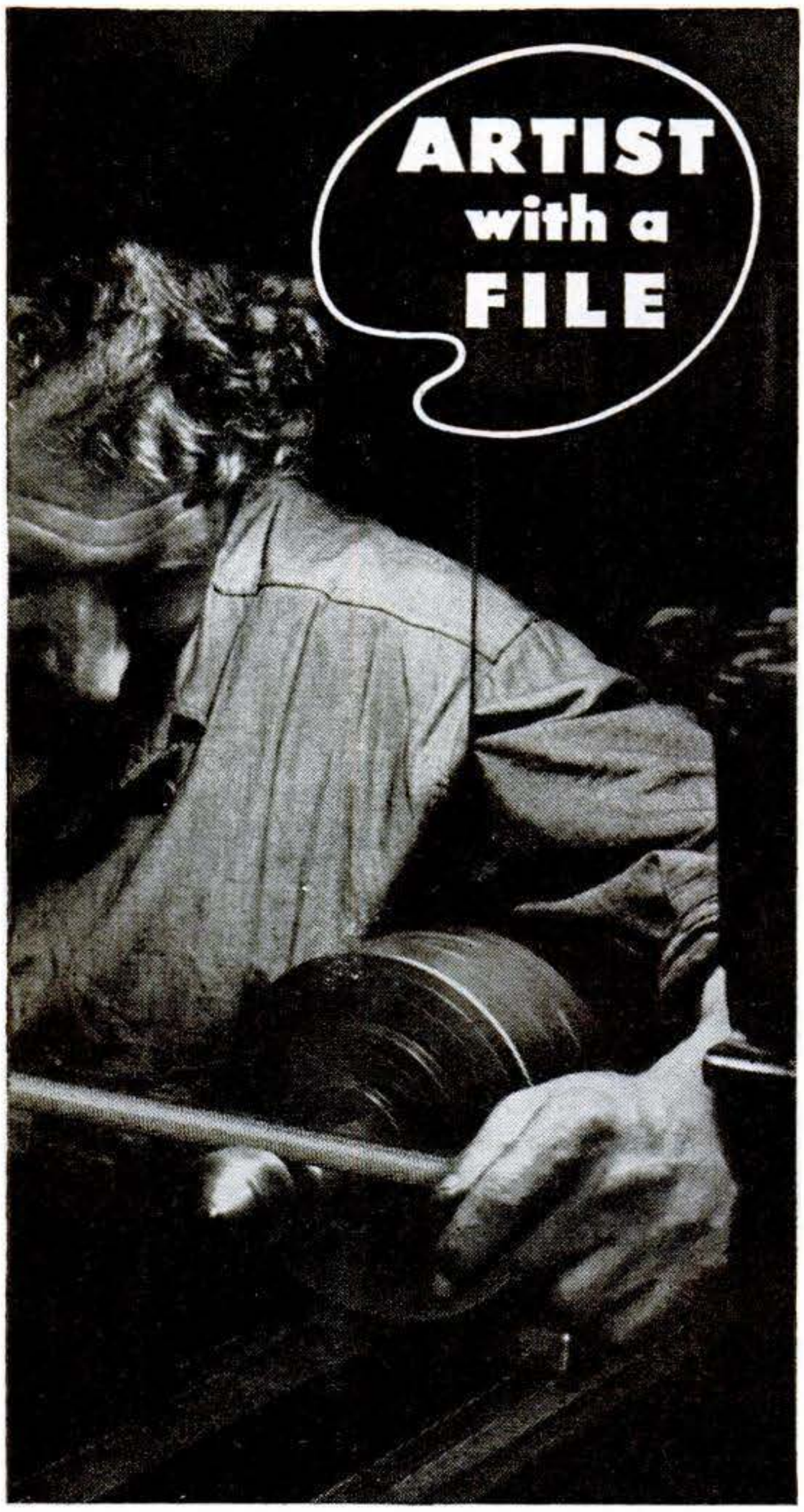

It is indeed an art to lathe-file a piece of work to proper dimensions; or to bench-file a precision part to micrometer measurements. Such skill is rarely achieved from practice alone . . . you've got to have *The right file for the job.*

That sound precept helps to explain why there are more than 3000 kinds, cuts and sizes in the Nicholson line of files—each of which can do a certain job on a certain type of metal better, faster or more economically.

An "M.F." (*M*aster of *F*iles) is a much sought "artist" these days!

NICHOLSON FILE CO., 19 Acorn St., Providence 1, R. I., U. S. A.
(In Canada, Port Hope, Ont.)

NICHOLSON FILES *FOR EVERY PURPOSE* NICHOLSON U.S.A. MADE IN U.S.A.

Buy War Savings Bonds and Stamps regularly.

Economical!
Speedy!

Cushman MOTOR SCOOTER

35 MILES *per HR.*
100 MILES *per GAL.*

You can't beat the New Improved CUSHMAN Motor Scooter for low-cost speedy transportation! Ten times faster than walking! 500 miles on $1 worth of gas!

Developed to the Nth degree by rigorous war-time service. Now even sturdier, more dependable, more comfortable than ever before.

Powerful 4 H. P. engine. Floating drive. Applies power as smoothly as Fluid Drive. To start, travel any speed or stop, merely touch hand accelerator. Improved springing, long wheel-base, balloon tires. Electrically welded all-steel frame.

3 models—as illustrated . . . or with 200-lb. capacity side car . . . or Package-Kar with 250-lb. capacity front delivery box.

AVAILABLE NOW for service inside war plants. Later—to individuals. Get the complete story now—be among the first to own a genuine CUSHMAN, when available.

WRITE! See your dealer who handles the CUSHMAN, or send for full details, photos, low prices. Send NOW!

CUSHMAN MOTOR WORKS, Dept. S-25, Lincoln, Nebr.

IT STAYS ON—RUST STAYS OFF

FIENDOIL

RUST INHIBITOR

Keep home tools, appliances, corrosive metal protectively coated.

35c Bottle Hdwe.—Sptg. Goods Dealers

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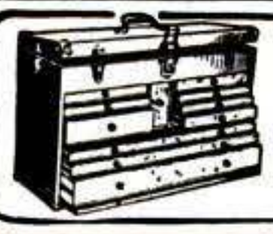

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Genuine GERSTNER Tool Chests are built for many more years of satisfying service. Free catalog for Machinists and Toolmakers.

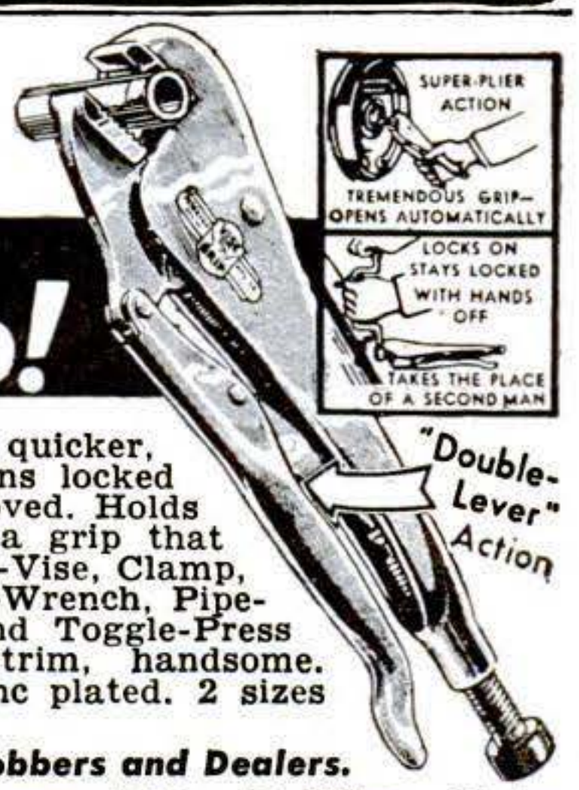
GERSTNER TOOL CHESTS
545 Columbia St., Dayton 7, Ohio.

Tyson TODAY'S HEAVY-DUTY **TAPERED ROLLER BEARING** With More Load-Carrying Rollers

TYSON BEARING CORPORATION • MASSILLON, OHIO

VISE-GRIP WRENCH

Gives Your Hand a TON-Grip!



Does more things, easier and quicker, than any other tool! Remains locked to the work with hands removed. Holds anything, any shape, with a grip that never slips. Is actually Hand-Vise, Clamp, Super-Plier, Adjustable End-Wrench, Pipe-Wrench, Locking-Wrench and Toggle-Press —ALL IN ONE! Light, trim, handsome. Made of fine alloy steel. Zinc plated. 2 sizes —7" and 10".

Sold through Tool Jobbers and Dealers.

PETERSEN MFG. CO., Dept. P-2, DeWitt, Nebr.

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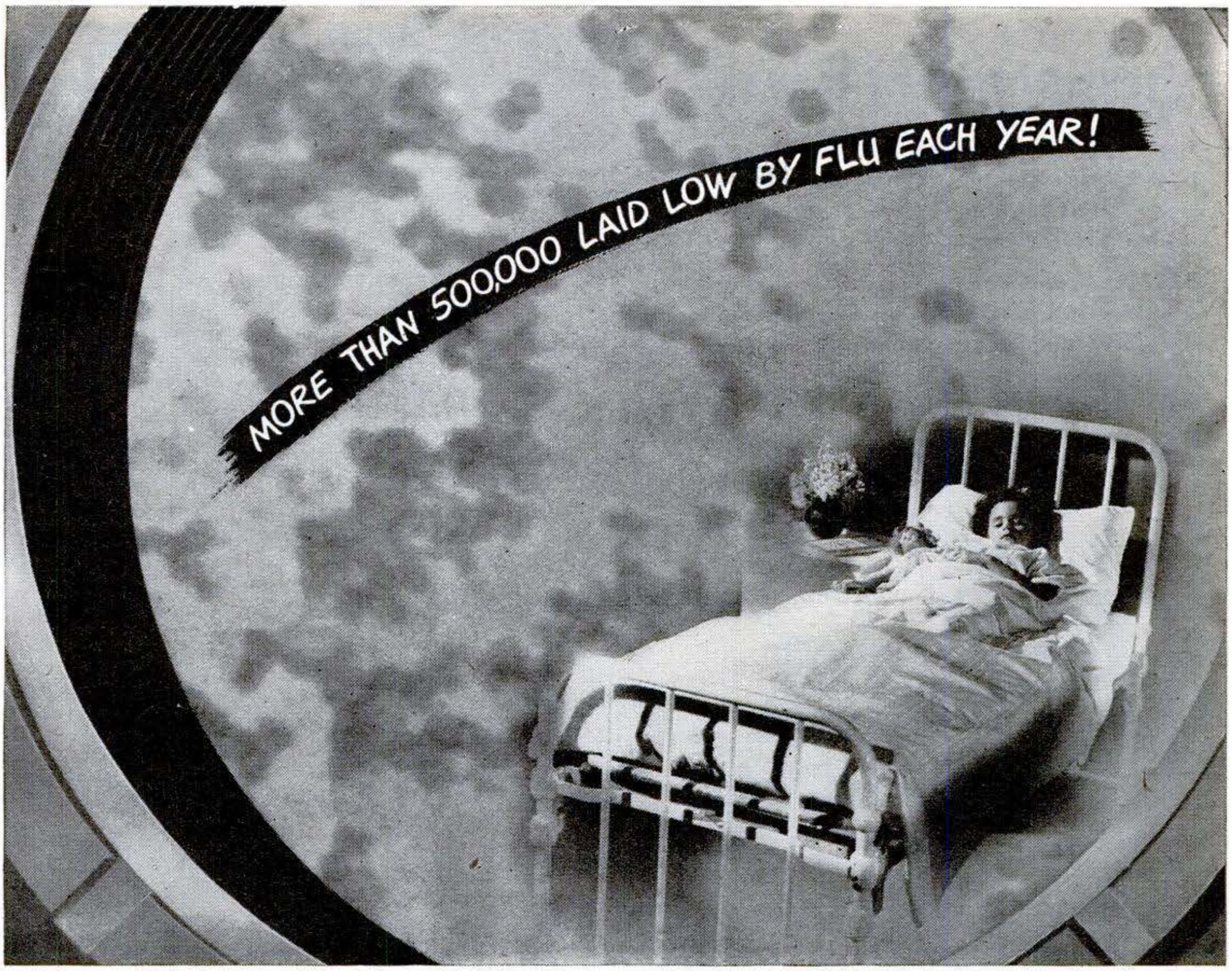


to destroy 'em you have to see 'em

Microscopes are gunsights in Medicine's battle on bacteria.

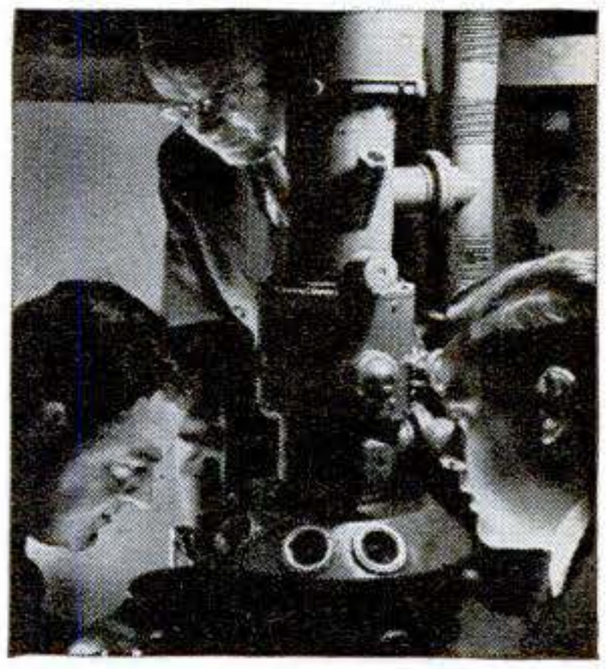
Optical microscopes, however, were not powerful enough to "draw an accurate bead" on the deadly virus that caused influenza.

But today, medical men have seen what no optical microscope could bring into focus — the infinitesimal influenza virus that previously had lain craftily camouflaged among larger cells.

This revelation came about through the Electron Microscope, developed by scientists at RCA Laboratories. And now, having been seen, influenza may be forced to unconditional surrender, saving the lives of thousands each year.

Here is but one facet of the genius shown by scientists behind RCA research . . . the "ever-onward" research that saves lives or creates a better radio with equal skill . . . the "there-when-you-need-it" research that gave super-secret equipment to the United Nations . . . the "way-ahead" research that goes into everything made by RCA.

When you buy an RCA radio or phonograph or television set or any RCA product, you get a great satisfaction . . . enjoy a unique pride of ownership in knowing that you possess the very finest instrument of its kind that science has yet achieved.



They see what human eyes have never seen before!

Drs. Arthur W. Vance and James Hillier, scientists at RCA Laboratories, with Mr. E. W. Engstrom, Research Director (standing), examine the RCA Electron Microscope that has useful magnification up to 100,000 diameters.

RADIO CORPORATION of AMERICA

PIONEERS IN PROGRESS

Buy War Savings Bonds and Stamps regularly.

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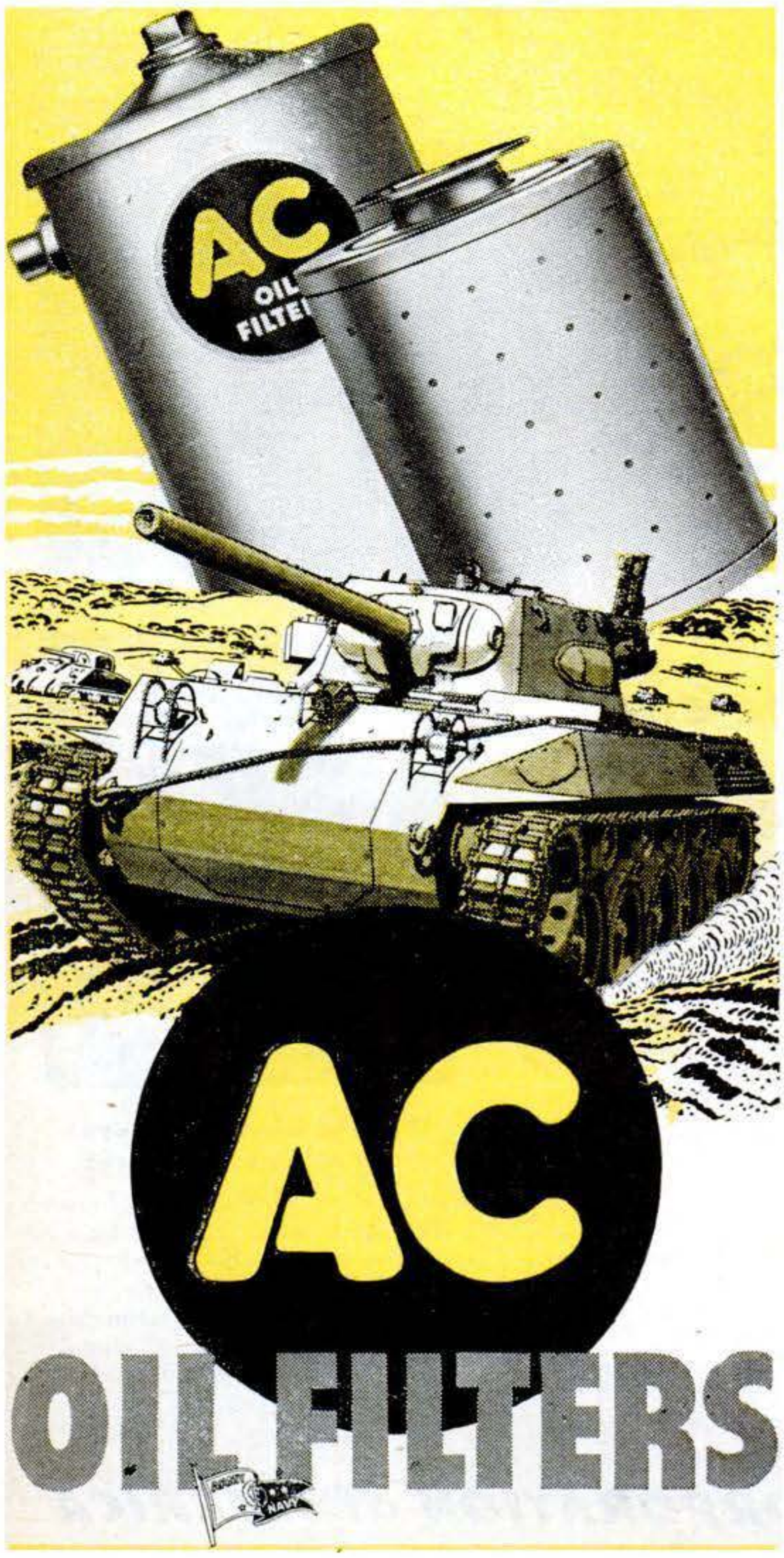
A LESSON FROM THE WAR

Every engine in every tank, "Duck," truck, jeep, or other fighting vehicle, is protected by adequate oil filters. Many of these are AC Military Oil Filters.

You, too, can prolong engine efficiency and life with an AC Oil Filter or Element —retard the clogging of piston rings— check carbon formation—get more work from your engine, at less expense.

If you now have an oil filter, choose improved AC elements for replacement.



BUY WAR BONDS • BRING VICTORY QUICKER

Buy War Savings Bonds and Stamps regularly.

NEW Atlas PATTERN SERVICE

FULL SIZE PATTERNS for making furniture, household equipment, cabinets, toys are now available through Atlas. They work like templates in airplane construction to save time and insure accurate workmanship.

NO. 3 STEP-SAVER KITCHEN UNIT

This is a handy piece of furniture for any kitchen. It's the same height as the usual "working" shelf. Note the toe-room, tray storage compartment, and generous shelves for oversize appliances that are so hard to put away. The Atlas pattern will help you make it quickly and easily. Price $ .50.

NO. 56 FOLDAWAY GARDEN CHAIR

The whole family will enjoy this comfortable chair during the pleasant summer months outdoors. It is also handy in the basement game room as it takes up little space when folded. This is a real fascinating project. Price $ .25.

• • •

Order patterns by number, inclosing exact cash, check or money order. Price includes mailing costs. Pattern envelopes show many other useful patterns available at low cost.

ATLAS PRESS CO. PATTERN DEPT.
Dept. B-3 P. O. Box 74, Pleasantville, N. Y.

REPAIR FURNITURE WITH HIDE GLUE

FRANKLIN *Liquid Hide* GLUE

USED BY FURNITURE MANUFACTURERS

Ready to use, no mixing, no heating means no chilled joints. Choice of fine craftsmen everywhere.

LOOK FOR THIS DISPLAY AT YOUR HARDWARE DEALER

or send 30 cents for ¼-pint to The Franklin Glue Co., Columbus 3, Ohio

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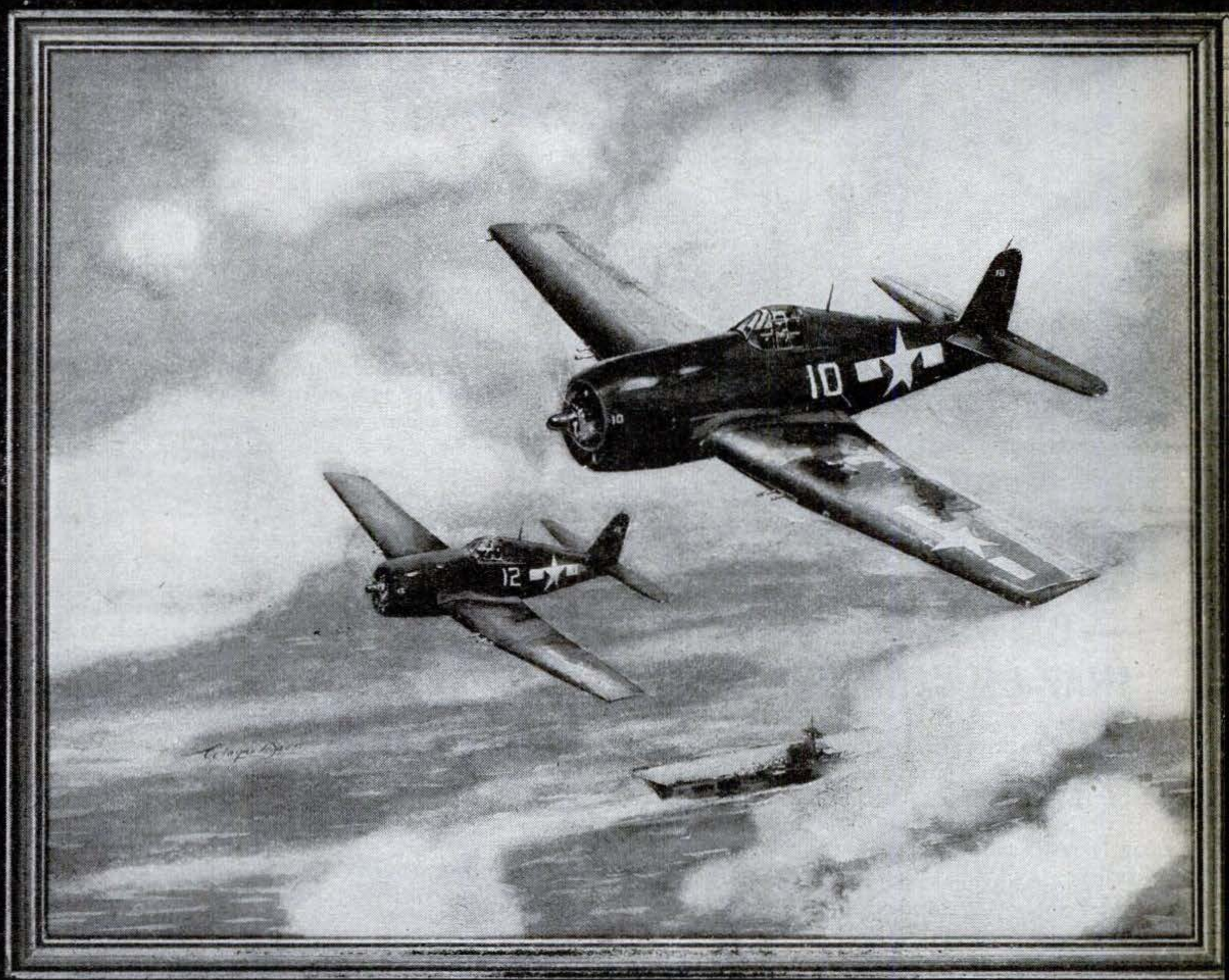
Grumman



U. S. Navy's Grumman Hellcats on Combat Patrol

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

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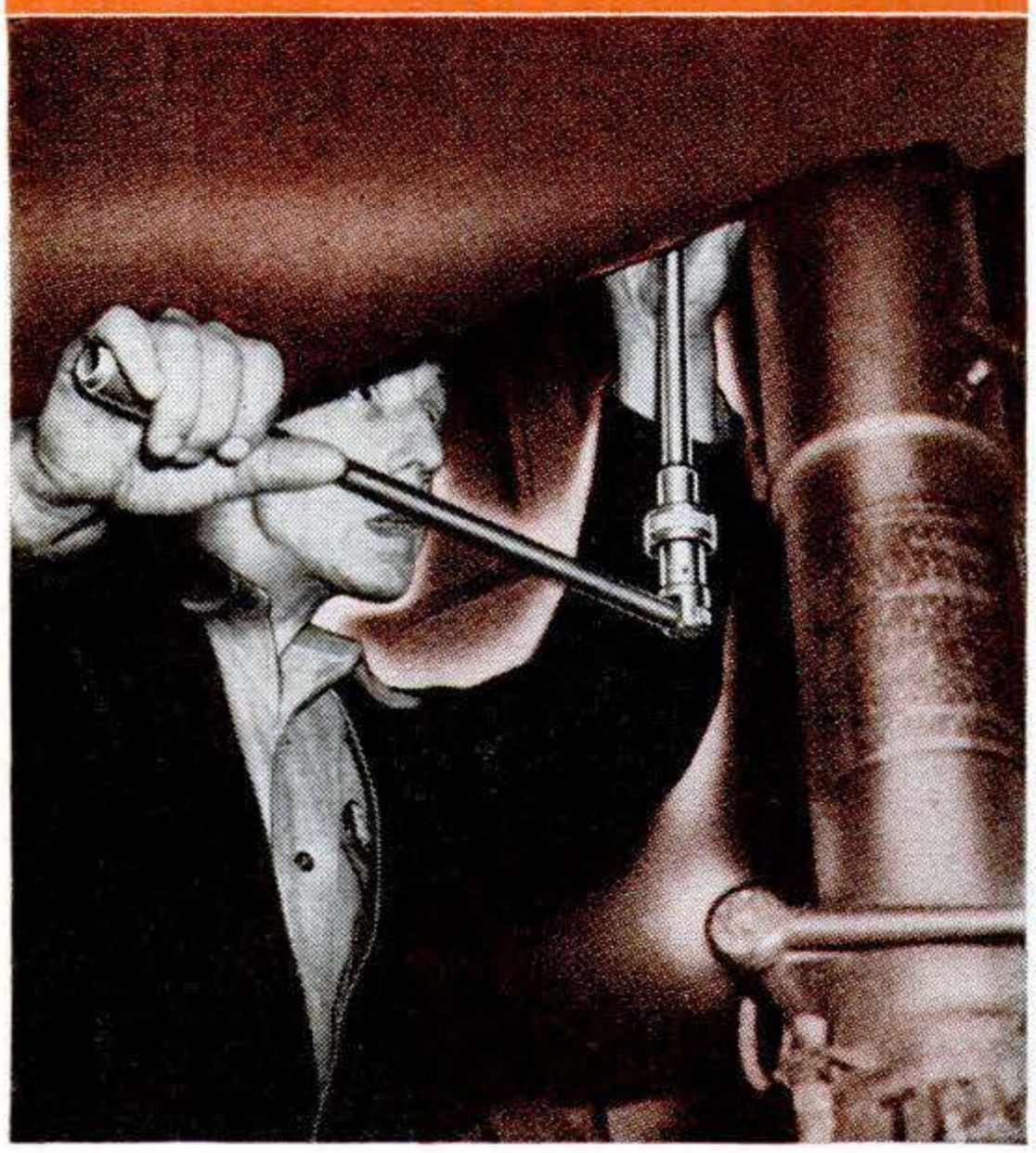
For more Speed in the "Tight Spots"

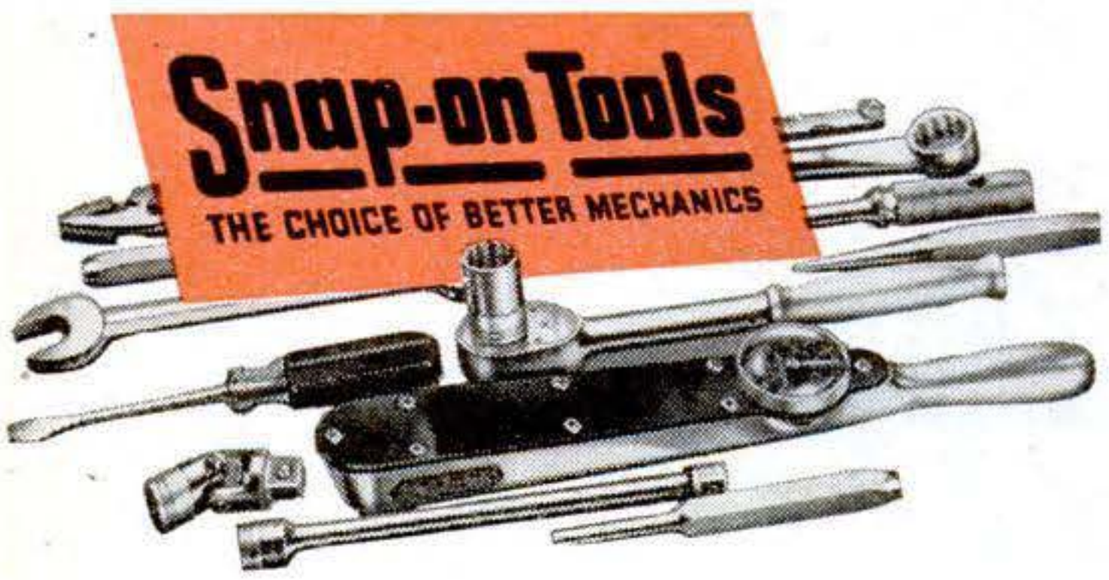


— USE FLEXIBLE, VERSATILE SNAP-ON "COMBINATIONS"

Remember back when "tight spots" were roundly damned as "bad design". Today they are the accepted penalty of *good design* . . . the unavoidable result of packing incredibly high performance into sharply restricted dimensions.

And for the toughest tight spots there are modern Snap-on tools . . . versatile "combinations" that reach into deepest pockets, grip hidden nuts securely, turn them easily, swiftly, solidly. The instant adaptability of Snap-on sockets, handles and ratchets, multiply the range of a compact Snap-on kit into hundreds of speed tools for specialized applications. *And frequently save the cost of specially designed one-job tools!* There are 3,000 Snap-on tools for production, assembly and maintenance operations. Write for catalog of the complete Snap-on line.

SNAP-ON TOOLS CORPORATION, 8060-B 28th Ave., Kenosha, Wis.



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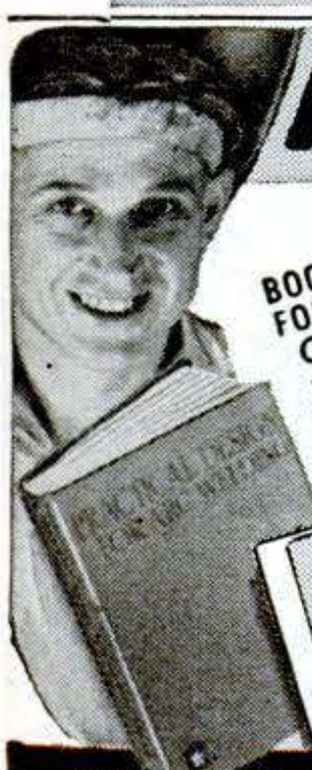

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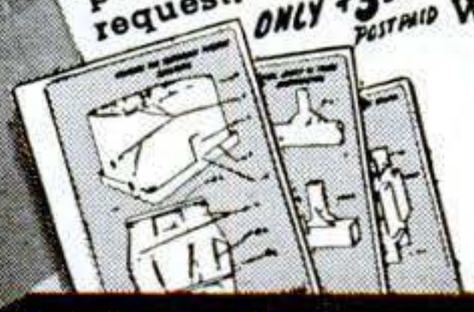

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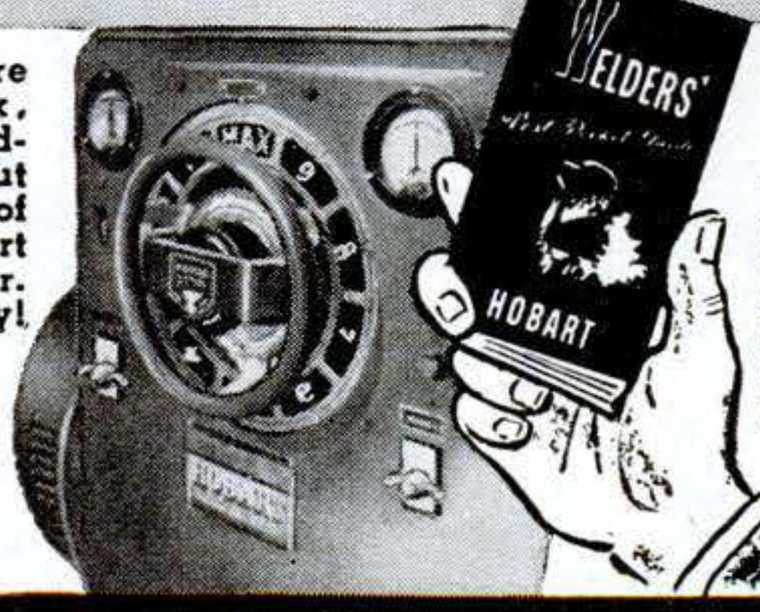

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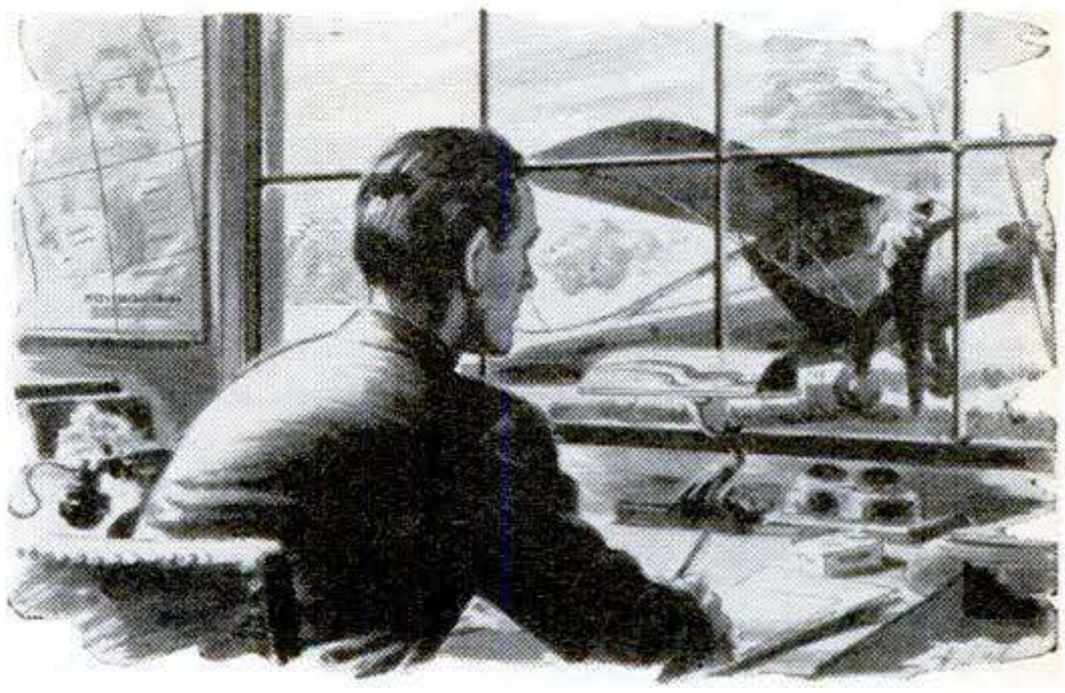

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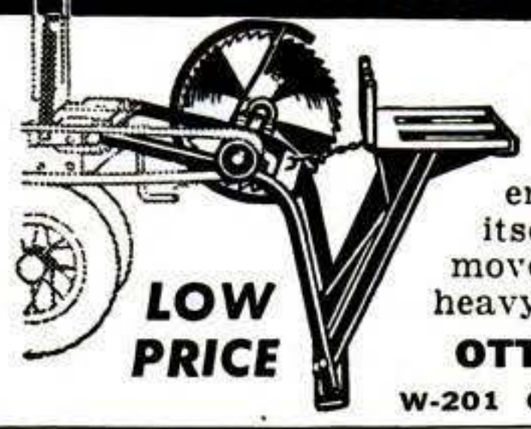

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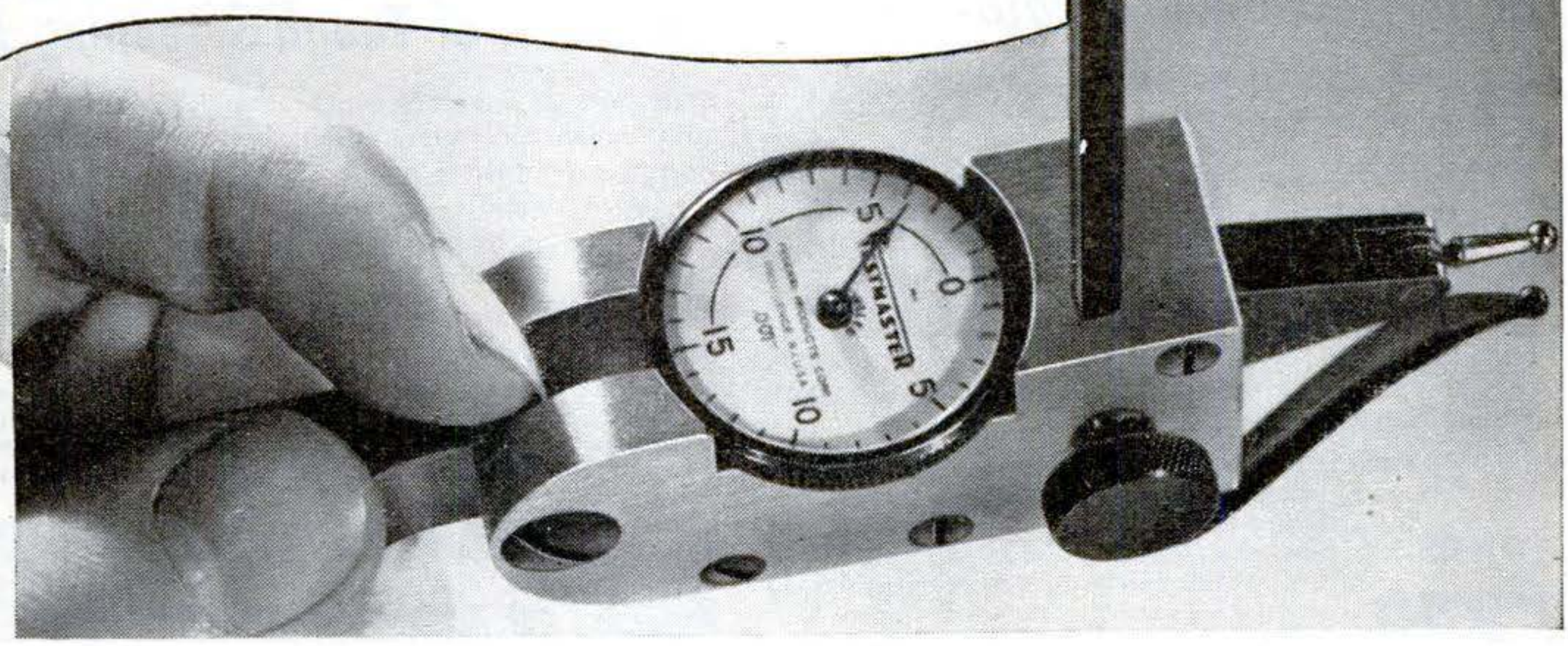

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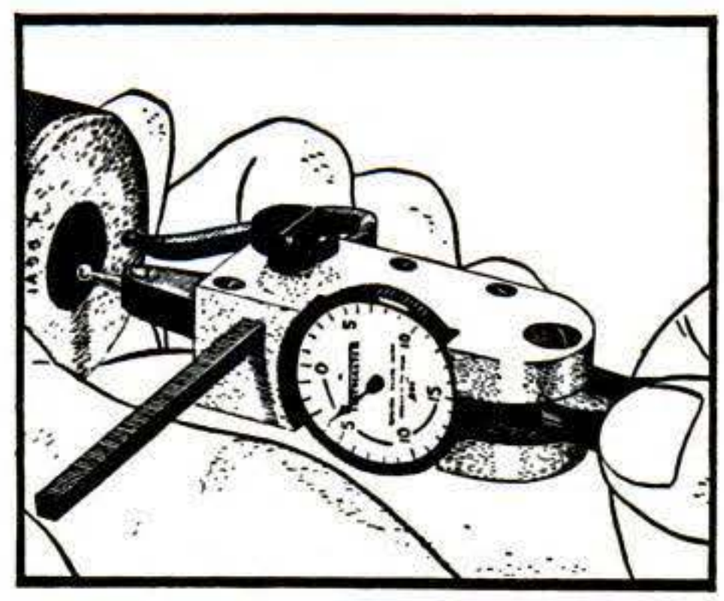
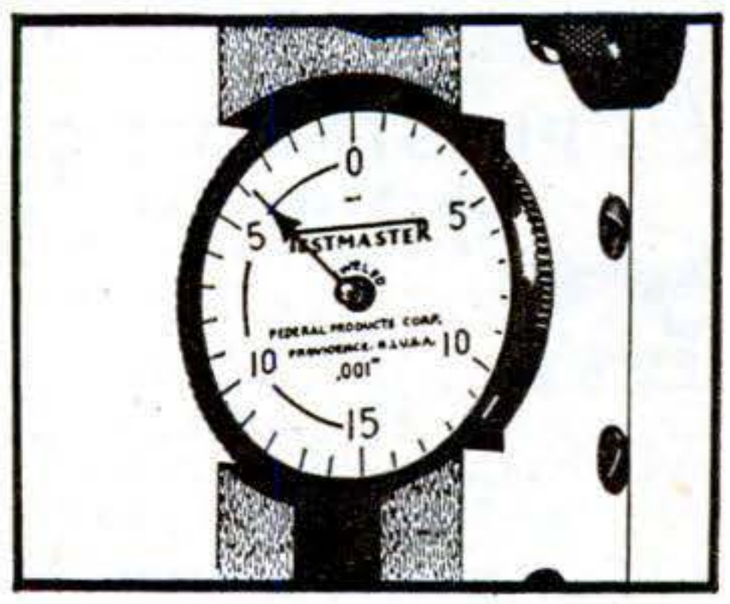


Determining correct setting for gage.



Closeup of dial showing simplicity and fast visibility.

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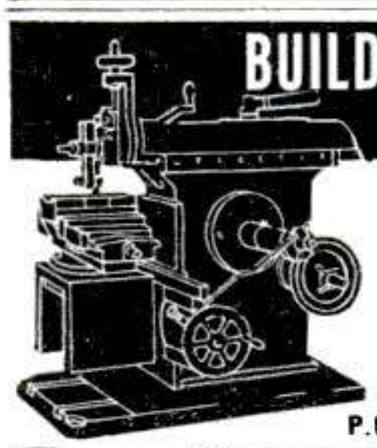

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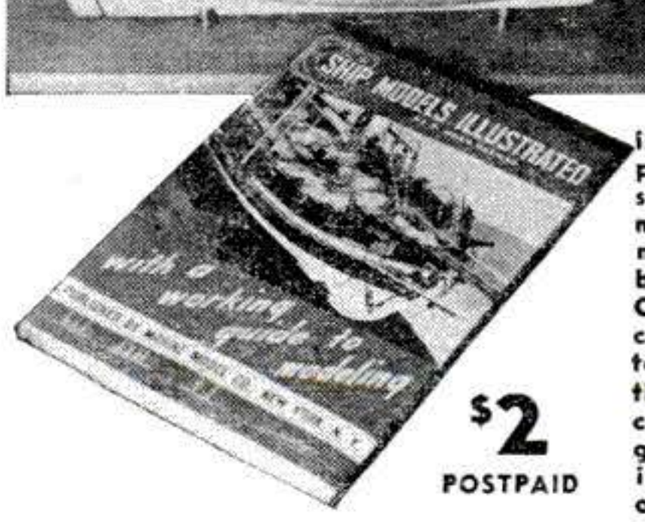

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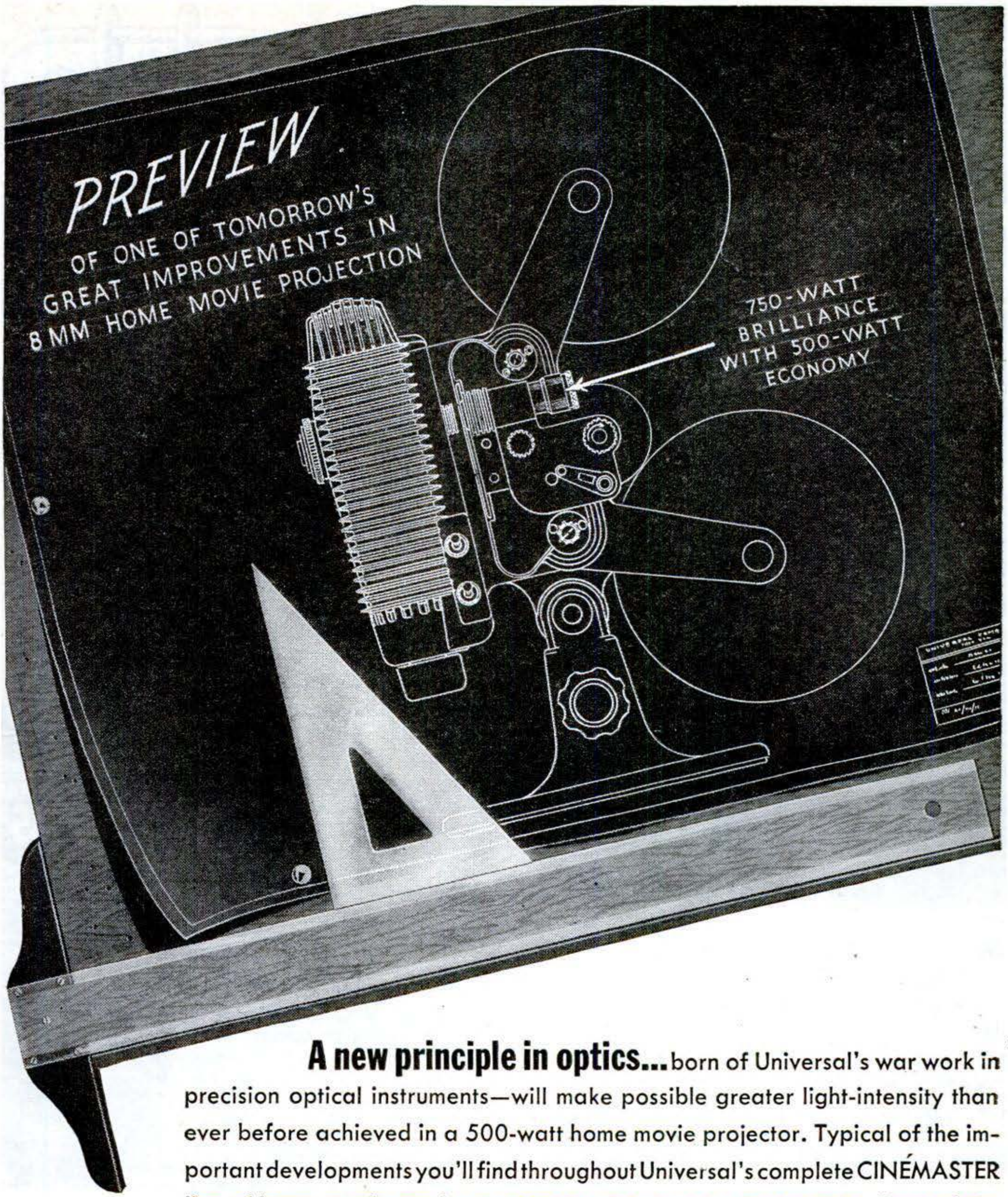

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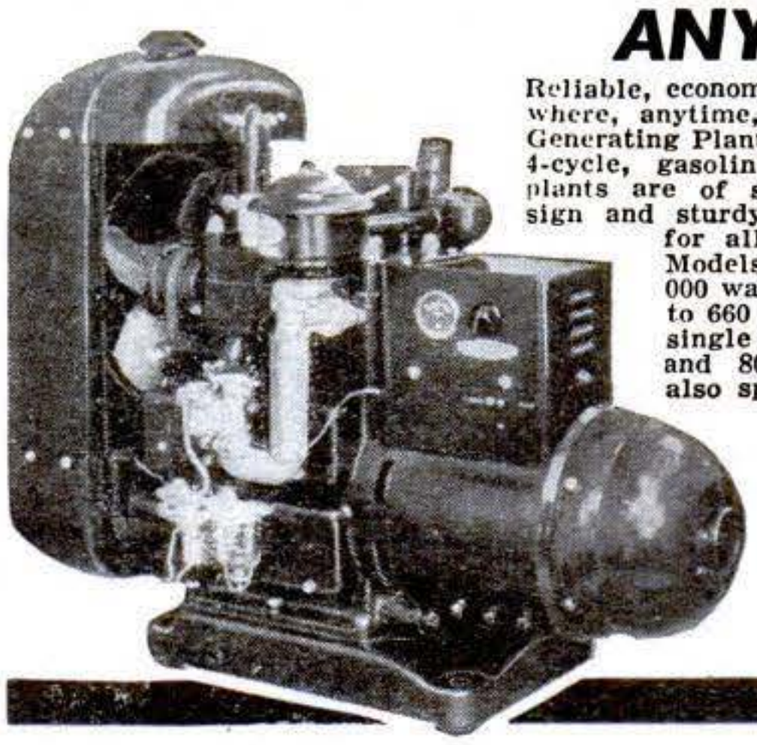

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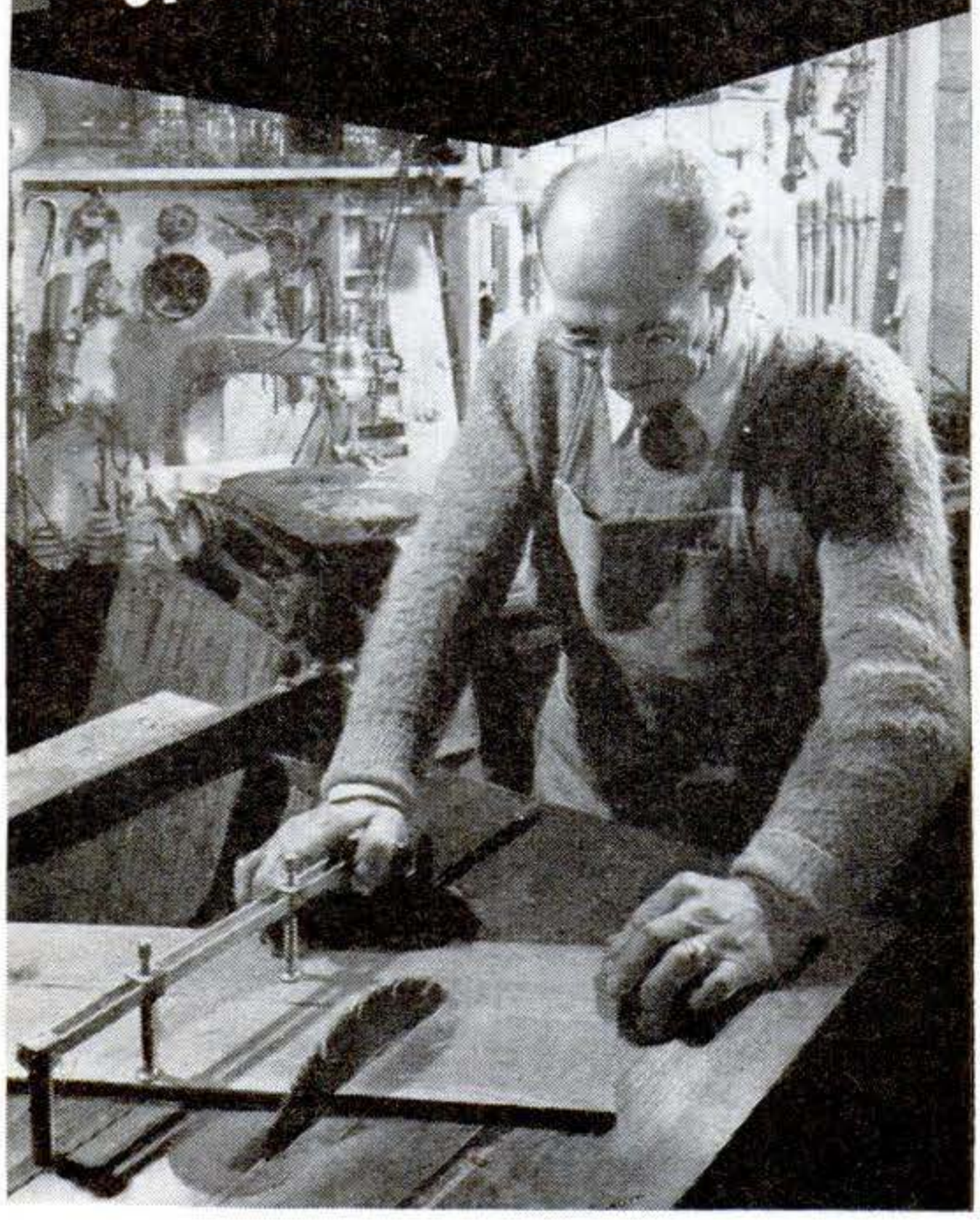

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3. Mail your entry to the F. J. Kirk Molding Company, Clinton, Mass. postmarked not later than midnight, January 31, 1945.

4. Submit as many ideas as you wish, but each idea must be entered on a separate sheet or blank.

5. All entries become the property of the F. J. Kirk Molding Co.

6. Judges' decision will be final.

7. Use your own stationery or write for Entry Blank.

JUDGES: Lucian Bernhard, Lucian Bernhard Studio
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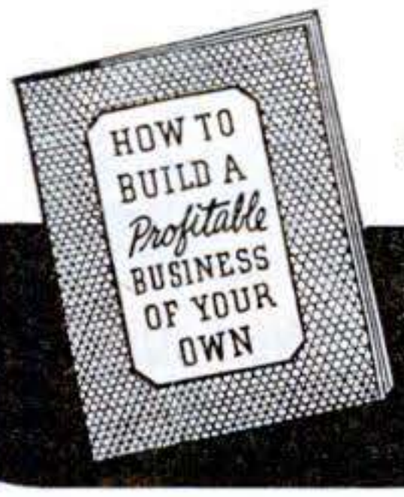

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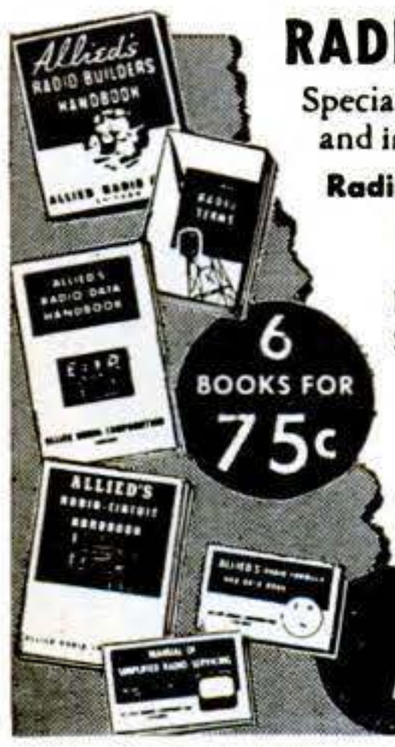

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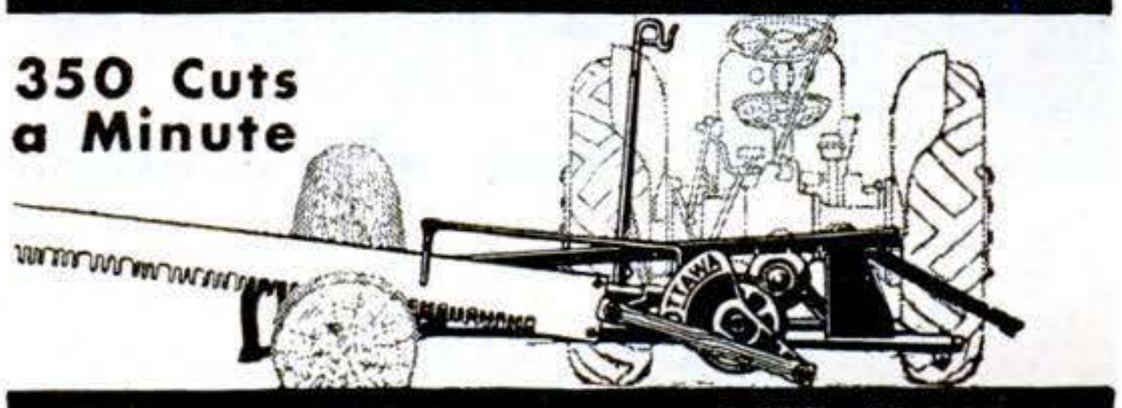

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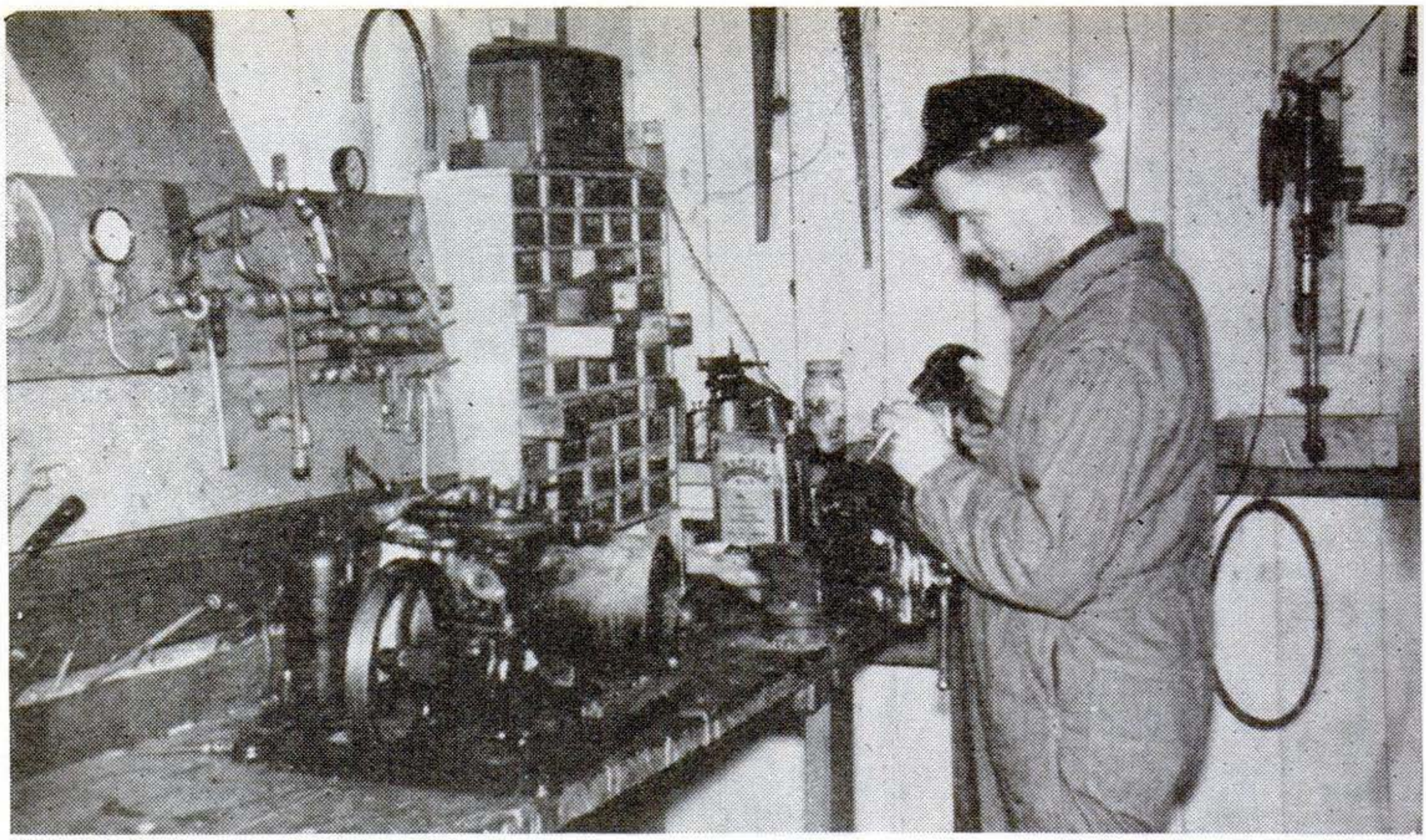

SO IT NEEDS FIXING

By S. T. CHRISTENSEN

the "Fix-it Man"

"WELL, I guess I'm the fellow to see, for I've repaired thousands of refrigerators (home and commercial both), vacuum cleaners, radios, washing machines, irons, fans, lamps, mangles, motors, etc. In fact, many of my customers call me their "electrical appliance doctor." And, "doctoring," I might add, has paid me a good substantial income for quite a few years. Funny, in a way, how I got started. Always liked to tinker and by experimenting around I found that most electrical appliances had many things in common. That, regardless of what the appliance was used for, or who the manufacturer was, the basic principles were much the same. From fixing my own appliances to fixing friends' and then for strangers at a fee, seems now to have been but a small step.

What to Charge?

At first, I let the owner decide the charge and, frankly, I was amazed at what I earned per hour. But then, when one figures what initial costs are involved in buying most electrical appliances, one can readily see that spending extra dollars for repairs is well worth while. Before long I was making more in my spare time repairing than from my regular job. The result . . . I went into business for myself. When war came, business boomed, for new appliances were not available.

For a while, repair parts (needed on some jobs) were a little difficult to get. But that situation seems to have adjusted itself for many repair parts have today the high priority rating of AA2. After all, we must provide for the health and well-being of our civilian population.

The Future Offers

Friends ask me about my future. And, I think I've got a grand one. Age is no handicap in repairing. I have in my files enthusiastic letters from repairmen ranging in age from 18 to 79 years. After the war, we're bound to see hundreds of new products on the market . . . products that the average person never dreamt of. These new products and our old appliances are all going to need at some time or other "fixing." Well, I'll still be the fellow to do it. The field open for appliance repairmen is unlimited. I don't worry at all about too much competition.

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To the contrary, I've prepared a complete course, chuck full of simple, easy to understand photos and drawings and written in the same non-technical language as this article. I know the course is good, because I have hundreds of men all over the country writing to me telling me how the course has helped swell their pockets with cash. If you too want to prepare now for your future, I suggest you read the next page and send me the handy coupon." Adv.

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I have received your Course in Appliance Repairing and I must say I am well pleased with same. I am only sorry I did not have said course some years ago. I have learned so much more through this course I would not part with it.—Charles Schwarz, Hamilton, Ohio.

The Course in Appliance Servicing arrived a few days ago. Want to take out a few minutes of my valuable time to let you know that this is just what I have been looking for ever since I opened up my Fix-It shop. I must admit that you told the truth when you said that it contains quite a bit more information than I bargained for.—P. J. Bretl, Sebring, Ohio.

I am a mechanic for the Western Union Telegraph Co. Three days after receiving the lessons in refrigeration I earned the exact cost of the course.—Henry S. Lee, Washington, D. C.

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If now in war work, start your home appliance repair business in your spare time and be set with a business of your own when the war is over. You don't need elaborate fixtures or expensive equipment to be a successful repairman. Operate from your garage, basement, vacant store, etc. Work as many hours as you wish . . . the home appliance repairman is his own boss. It's a profitable occupation for on many types of repairs it is usual for a repairman to charge on the basis of $5.00 to $6.00 an hour! *Prepare today and make sure of tomorrow's future.*

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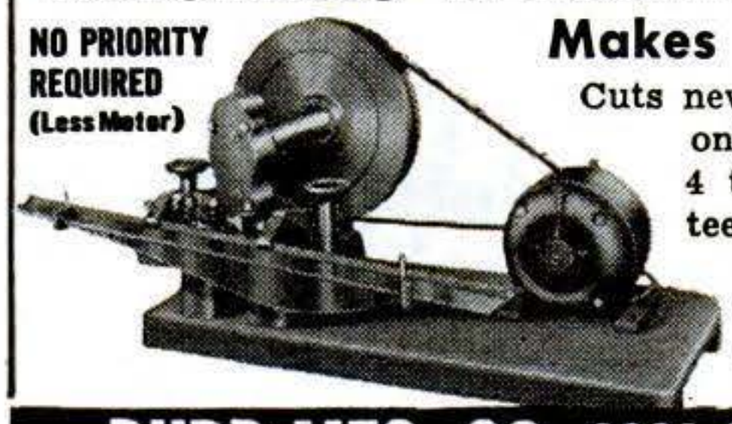

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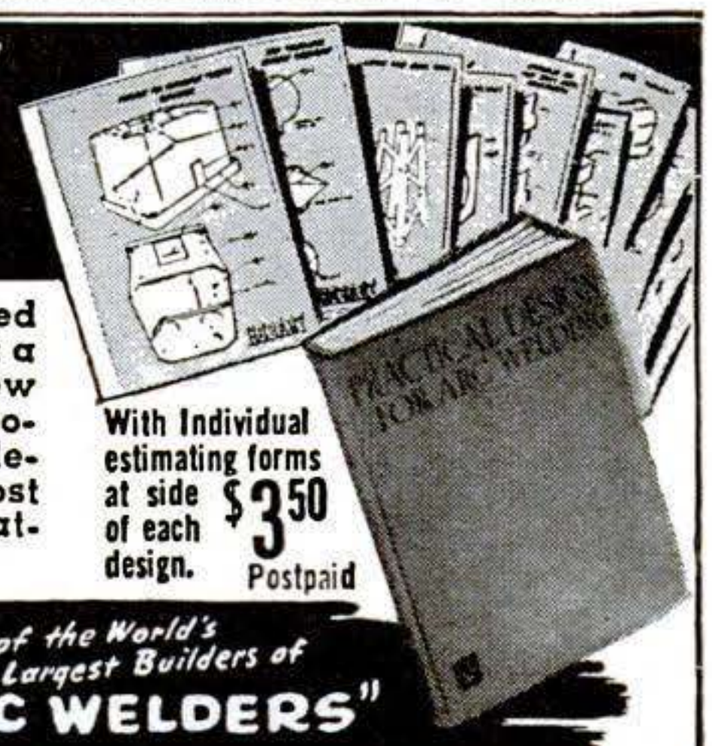

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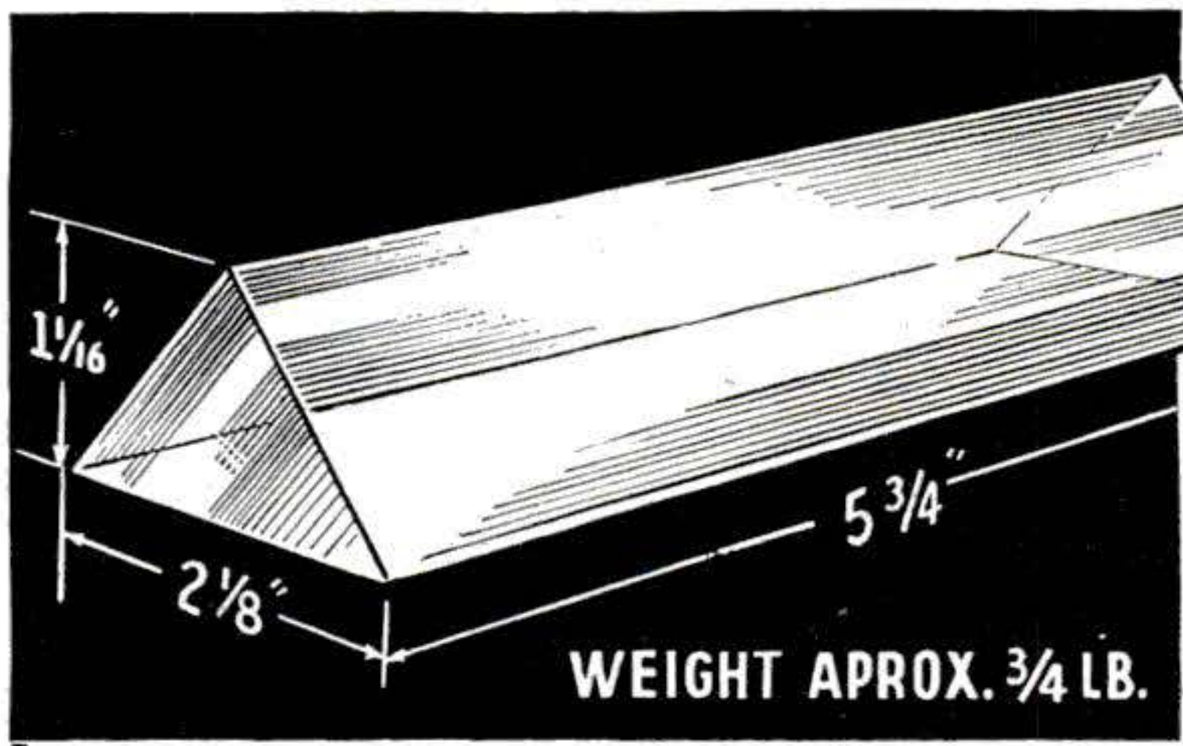

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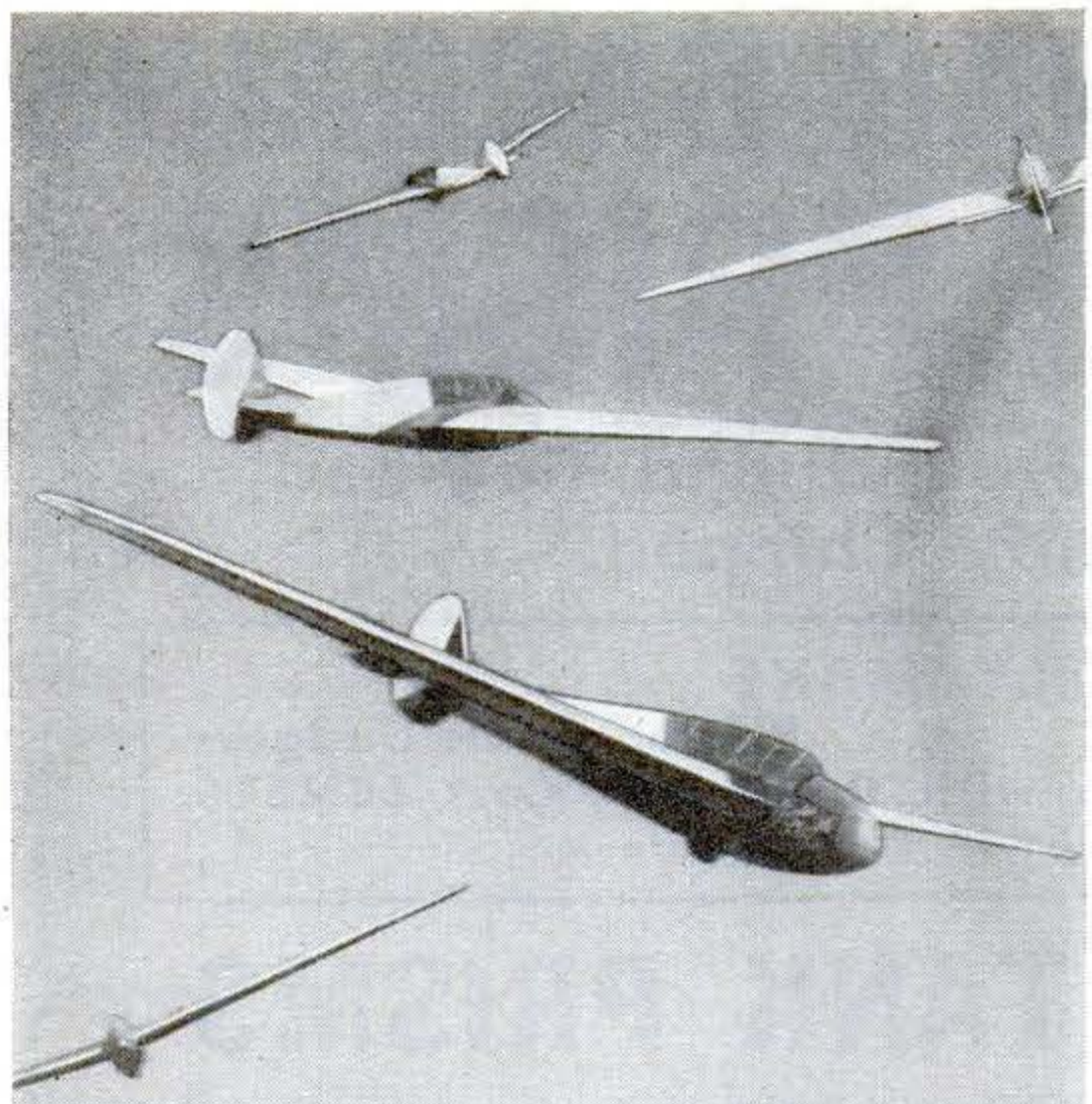

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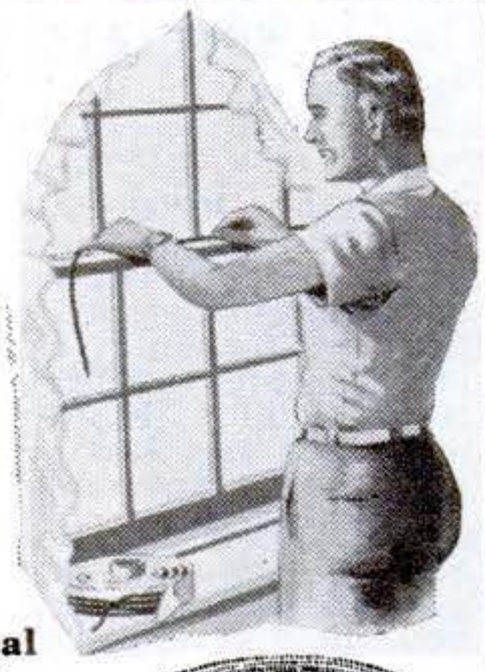

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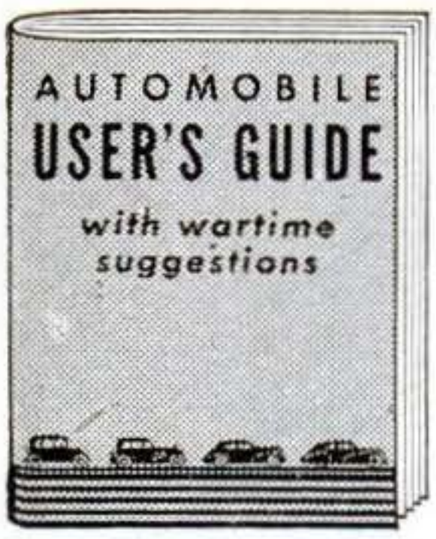

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Have You Heard About My

"HAVE-MORE" PLAN?

How to Raise Your Own Delicious Meat, Eggs, Vegetables, Etc. in Your Spare Time on as Little as ¾ Acre of Land!

Let Me Tell You How We Do These Things The EASIEST, LATEST, Most PRACTICAL Ways at Our Small Place.

Maybe you already are raising your own food—or at least part of it. Maybe you are even a full-time farmer. Or maybe you are a city-dweller just hoping and planning ahead.

Whatever your situation, I think you'll be interested in my Plan, because it's really a story—the true story of our place, of my family and me. It's the story of how we moved to the country outside of New York City . . . How I kept my regular job and how we've gone in for "back-yard farming" in our **spare time!**

If you are already doing something like this you'll want to "compare notes" with me. Maybe I can give you some new ideas . . . short cuts . . . help you get better results.

If you are **not** yet doing it, but are planning to, you'll find my Plan very helpful. It will tell you how to look for the **right kind** of place near your job, how to get started the easiest, most inexpensive way. My Plan will show you lots of short cuts, help you avoid many mistakes.

"One Hour or So a Day"

Some people may think this sort of thing takes a lot of hard unpleasant work. That is **not** so! It does take **some** time—but really not very much. We take care of the chores at our place in only one hour or so a day on the average! It does take **some** work, but it's not unpleasant—it's **fun!** And it does **not** take much land—even a fairly large city lot can be enough!

The secret, of course, is doing things the **easiest,** most **practical** ways, taking advantage of all the modern, scientific, labor-saving methods that have been developed in recent years! And it is these new, **easier, better** methods that my Plan tells you about! See right hand side of this page for list of things my Plan covers.

Mrs. Robinson and our son, Jack. The home-raised goose I'm holding weighed 10¼ lbs. at 10 weeks of age. All the food it ate was stale bread and grass growing around our place.

Healthful, Relaxing

Not only is it **fun** to have a garden, and to raise lots of the other foods you need—it's **healthful. Really fresh** vegetables, milk, eggs, meat, etc., have more vitamins and other health giving qualities in them. They **taste** much better—and, of course, raising your own you can have all you want, **without** worrying about ration points!

Being outdoors around the place is healthful, too. The whole family eats better, sleeps better, feels better and gets along together better. Your children, if you have any, have more wholesome surroundings. This "way of life" is really the soundest foundation for family happiness.

Saves on Food Bills and Ration Points

Food prices are very high now—everybody knows that! So, just figure out how much you'd save if you raised 50% to 75% of all the food you buy! Not only that—it doesn't take any ration points to raise your own! You can have **more** food, **better** food, and save money doing it!

Security Against Hard Times

Maybe you'd like to retire some day. If there's a postwar depression, you might even lose your job. I hope not, but it **might** happen, and if it did, wouldn't it be swell to have a place where you could raise most of your food, where you could get by with very little cash income? Wouldn't it be a good idea to **know how** to do these things even if you never have to? I can tell you it sure gives **me** a feeling of independence and security and I'm sure it would do the same for you!

Well, I guess you can see I'm pretty well "sold" on this whole idea. It's fun, it's healthful, it saves you money, you eat better, you feel secure and independent. That's why I've told the whole story about it in my "Have-More" Plan, and why I'm offering my Plan for sale. (Price $1.00.) I wish I could **give** it away to everybody that might be interested, but of course I can't, and after all one dollar isn't very much.

So, if you're interested either to "compare notes" with me or to plan ahead—then send me your name and address and one dollar and I'll send you my Plan by return mail.

Right now is an excellent time of year to start!

Yours for "a little land and a lot of living"—

Ed Robinson

Box 2802, Noroton, Conn.

NOT A BOOK!

50,000 WORDS • 73 PICTURES, DIAGRAMS

My "HAVE-MORE" Plan tells, by clear-cut diagrams, pictures, easy-to-read directions, tables, charts, etc., how we have applied the easiest, most practical, labor-saving methods to having such things at our place. You can easily do the same.

How to choose—to rent or buy—the **right kind** of a place of your own, near your job. (If you don't already have a place.)

A wonderfully bountiful garden with half the work.

Broilers and roasters—at about 16 cents a pound.

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Geese, turkeys, squabs, ducks—easy, interesting, delicious.

A lovely flower garden for mother.

New amazingly easy ways of preserving foods—they **taste** far better, too.

75 pounds of honey—only 8 hours' work.

Extra income selling your surplus crops.

Fruit instead of shade trees.

Grapes, berries—your investment back each year.

Etc., Etc., Etc.

What My Plan Tells You about any **one** of these things can easily be worth several times the price of the whole Plan (which is $1.00). So even if you are interested in only **one** or **two** of the subjects you need not hesitate to order my Plan. Besides, if for any reason you aren't more than satisfied with it, I'll gladly refund your dollar without question!

DO YOU WANT TO SEE MY PLAN?

If you do, just put a dollar bill or dollar money order (if bank check, $1.05) in an envelope with your name and address and turn it over to Uncle Sam's mailman. I'll send your copy of my Plan by return mail. If for any reason you aren't pleased with it, let me know and I'll refund your money without delay and without question. Address:

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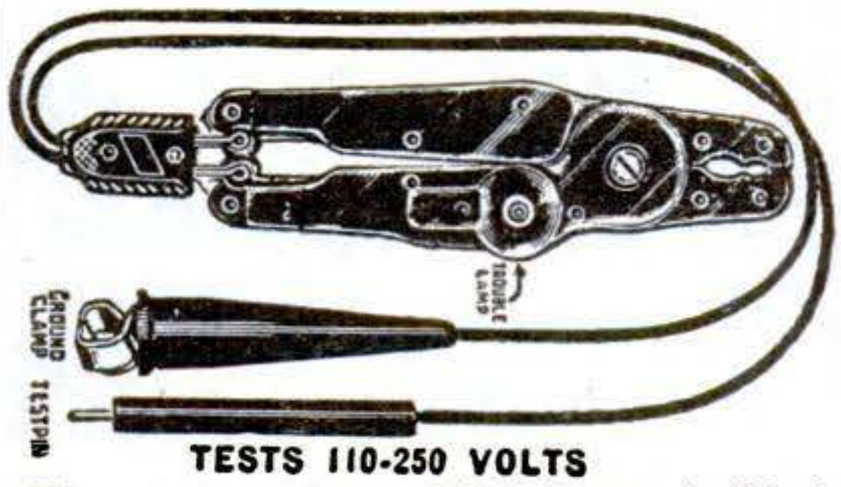

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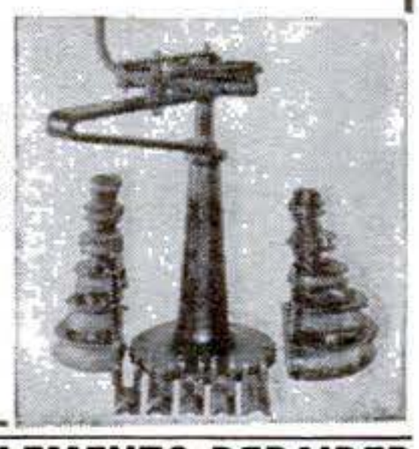

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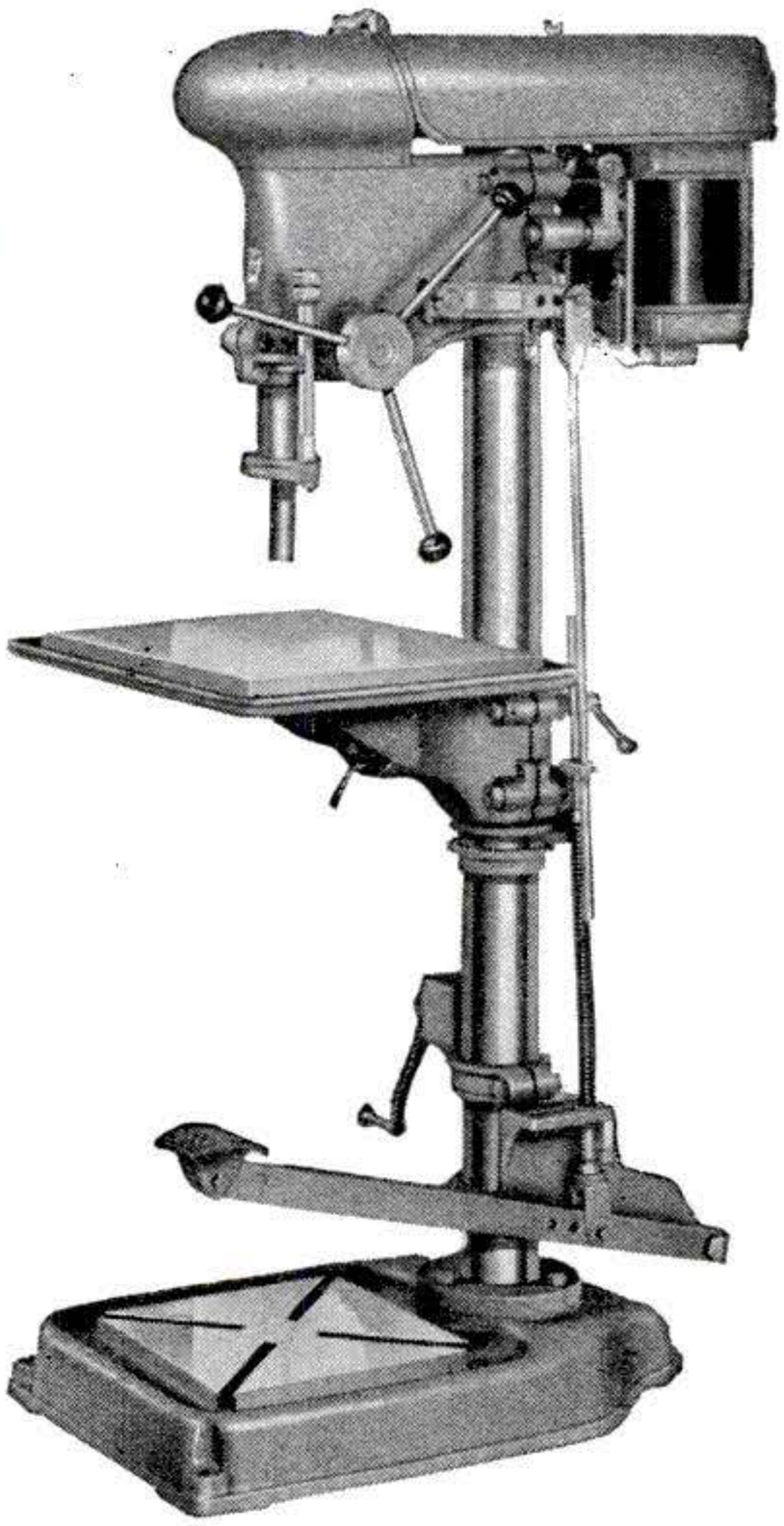
A New Low-Cost 18" Drill Press That Can Really Take It



This New Duro 18" Drill Press has been designed and built to handle a much heavier load continuously than ordinary low-priced units. Has many new features including: special design for quick-changing of belts; head casting slotted to provide take-up when wear develops from movement of quill; six-spline telescopic self-aligning spindle that reduces play; heavy ribbed cast iron table and base with large machined surface and grooves for collecting coolant; base provided with "T" slots for bolting jigs; improved simplified depth gauge. Efficient production foot feed available. Specifications include: ¾" capacity. No. 2 Morse Taper. 4 New Departure Ball Bearings. Speed range 425 to 2030 R.P.M. Spindle travel—5". Drills to center of 18" circle. Maximum distance from base to spindle—49". Maximum distance from table to spindle—19". Overall Height—68". Size of overall base—18" x 28½". Diameter of column—3½". Weight of Model A3088 (as illustrated) less motor, 350 lbs. Also available in bench model.

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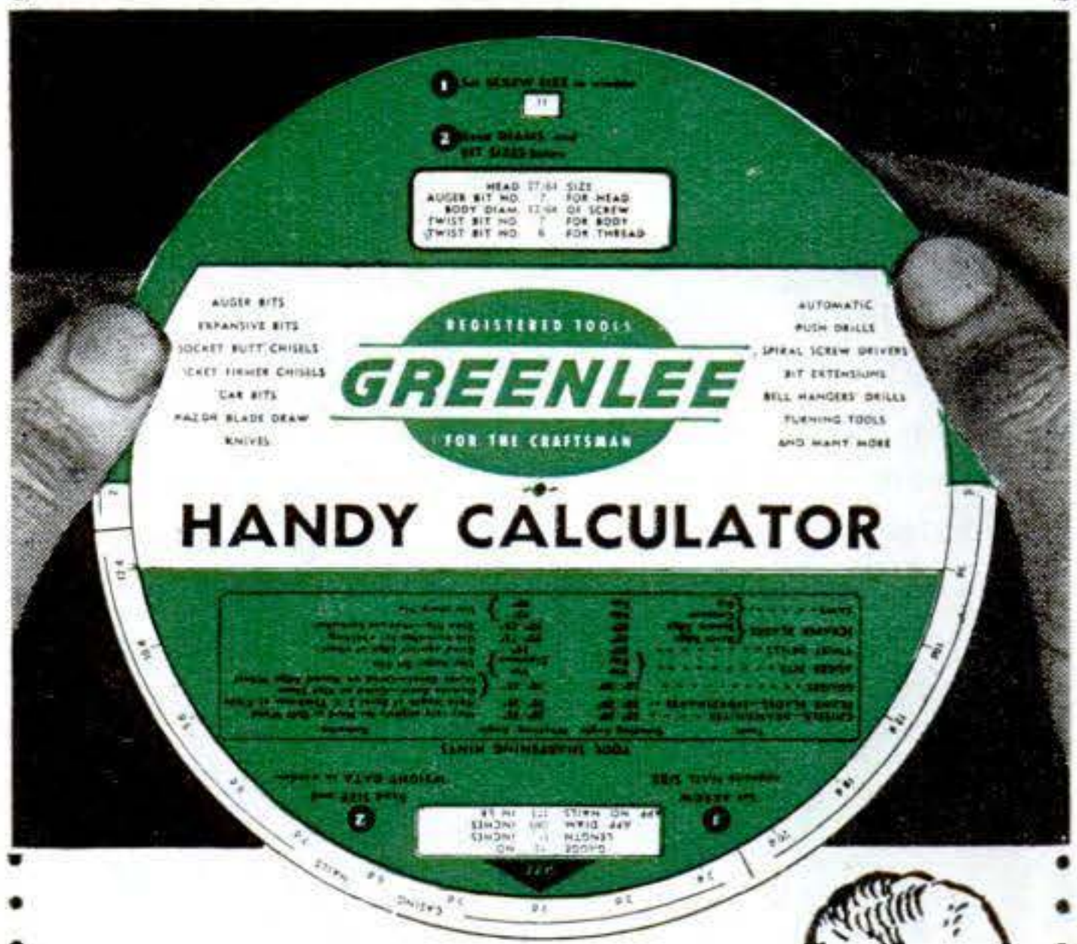

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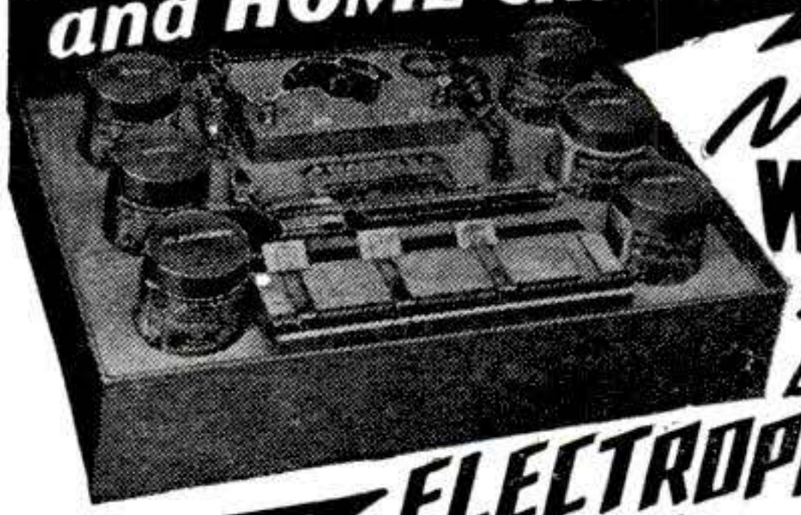

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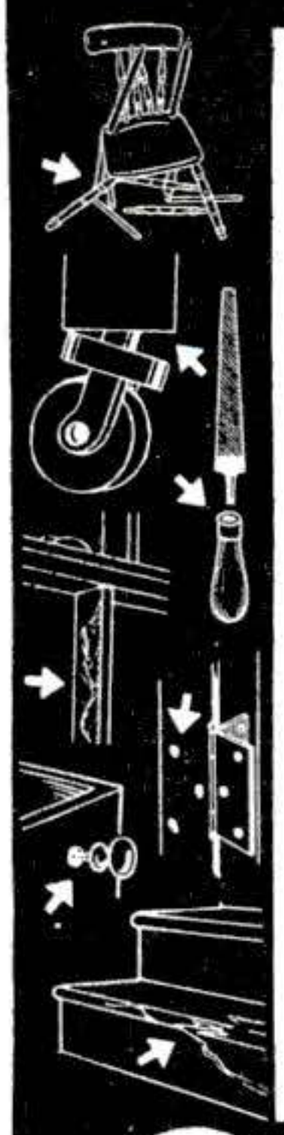

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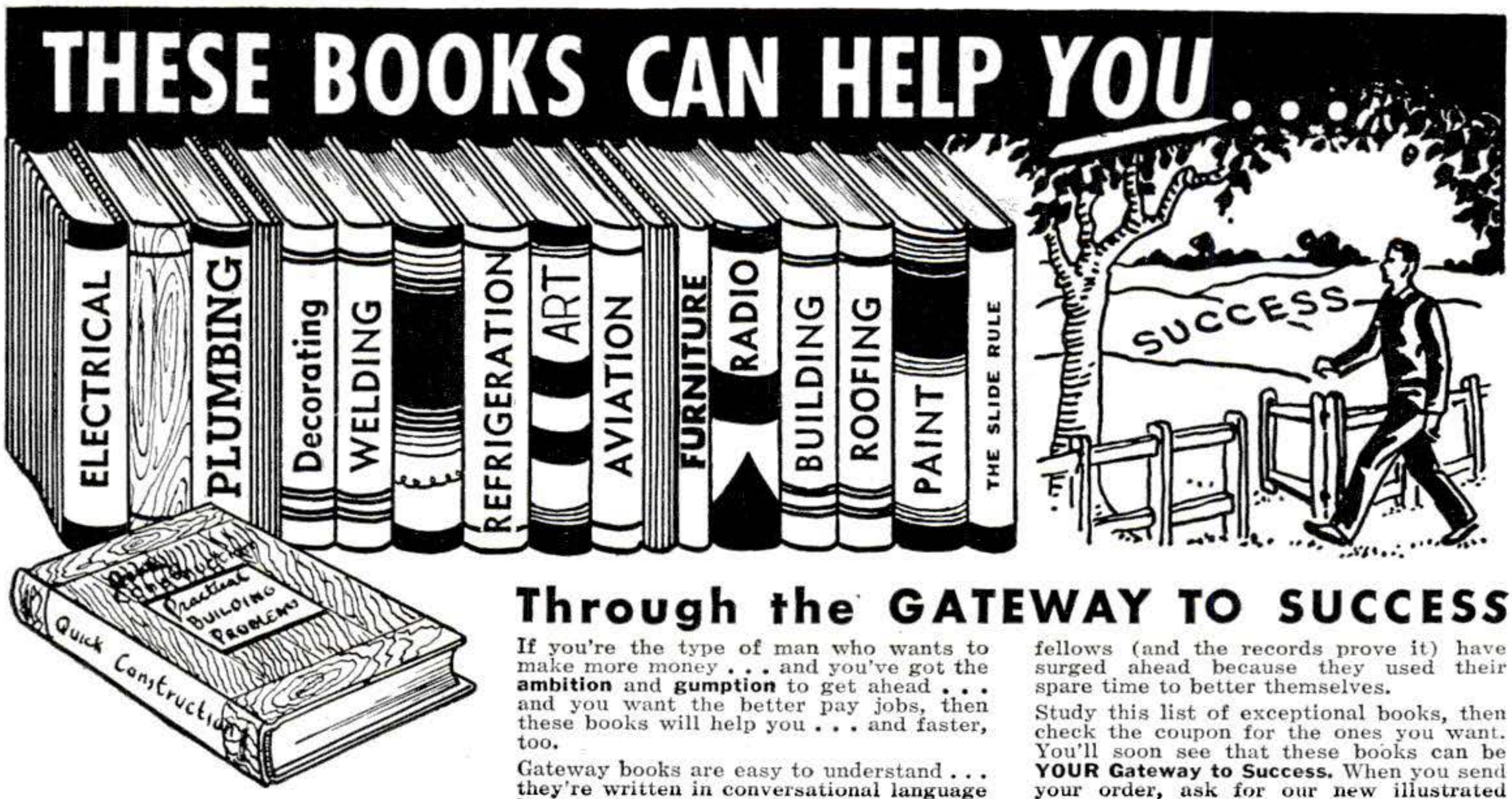

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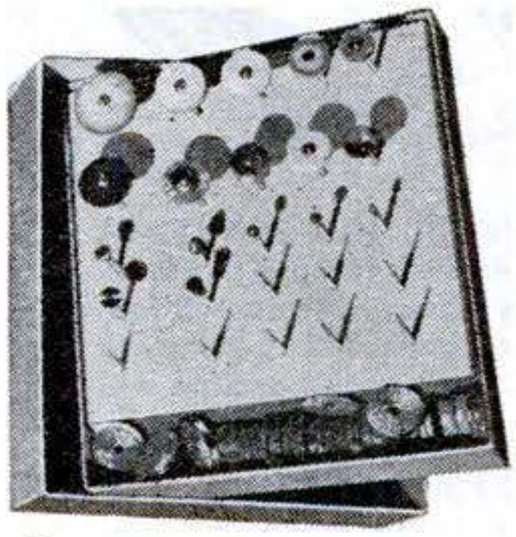

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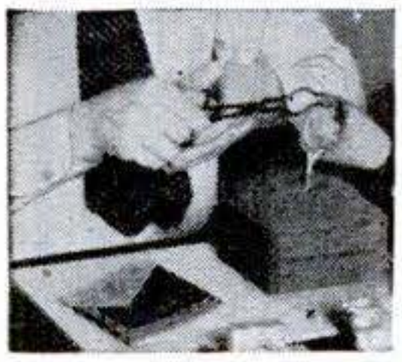

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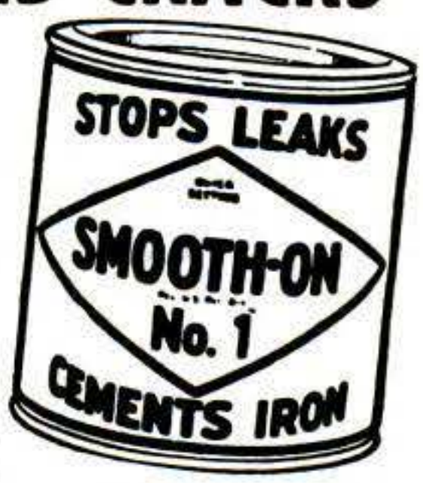

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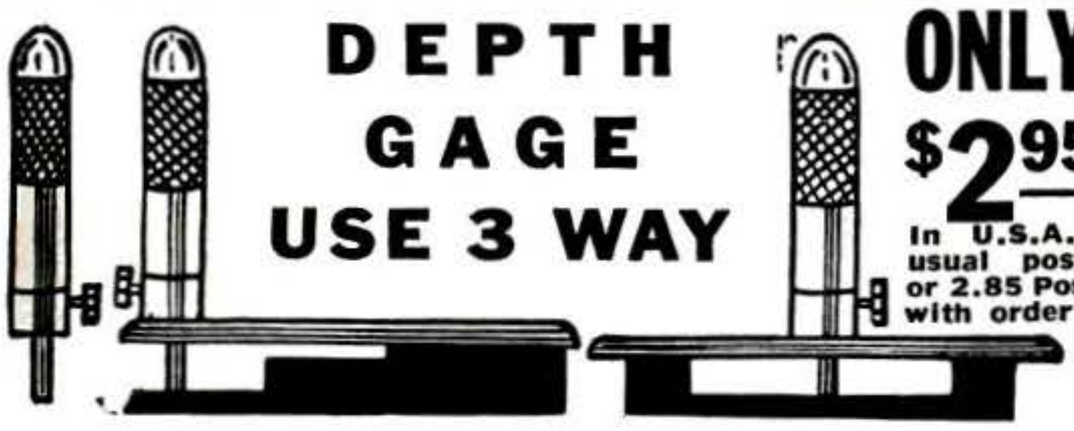

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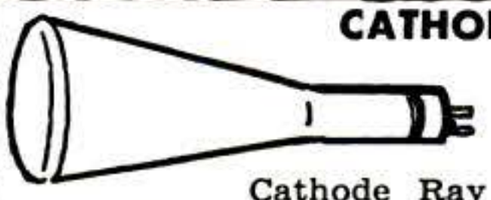

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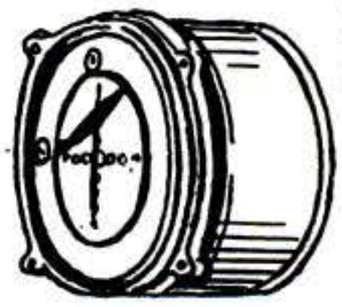
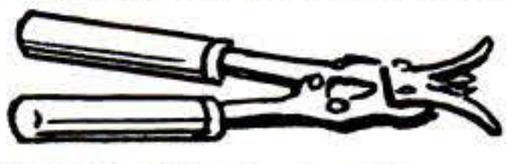


14 INCH BOLT CLIPPERS



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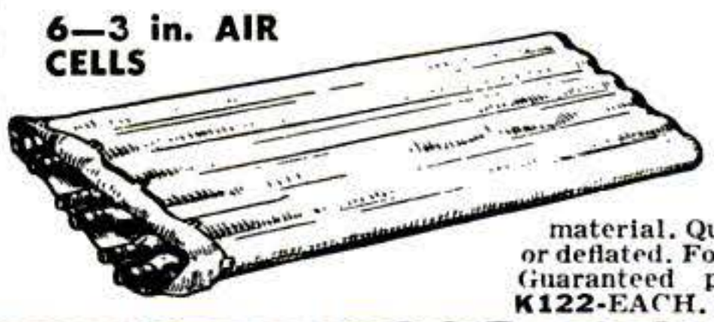

For campers, outdoorsmen, boy scouts, servicemen, etc. Six separate (slightly used) air chambers provide a 3 inch cushion of air. Measures 24x54 inches—fits cot or sleeping bag. Outer envelope of black, waterproof, rubberized material. Quickly inflated or deflated. Folds compactly. Guaranteed perfect.

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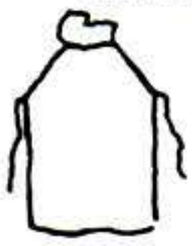

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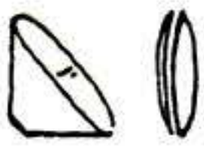

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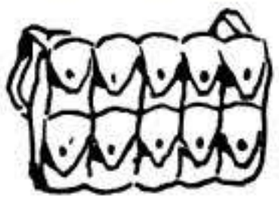

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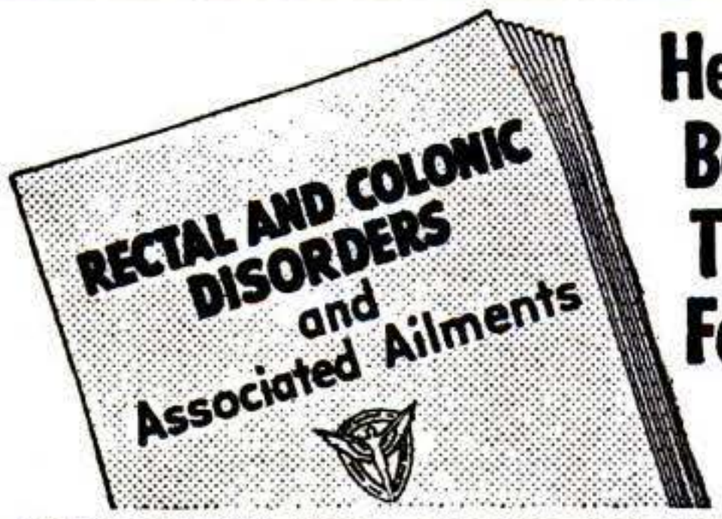

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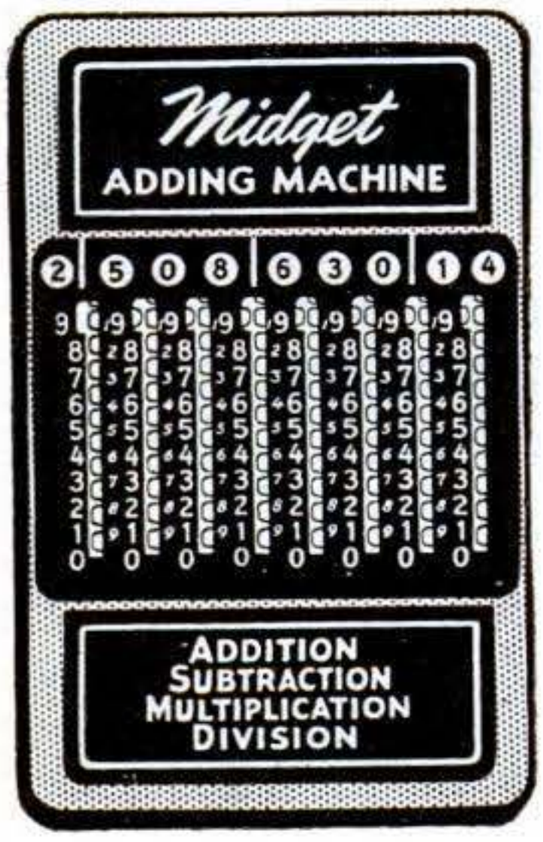

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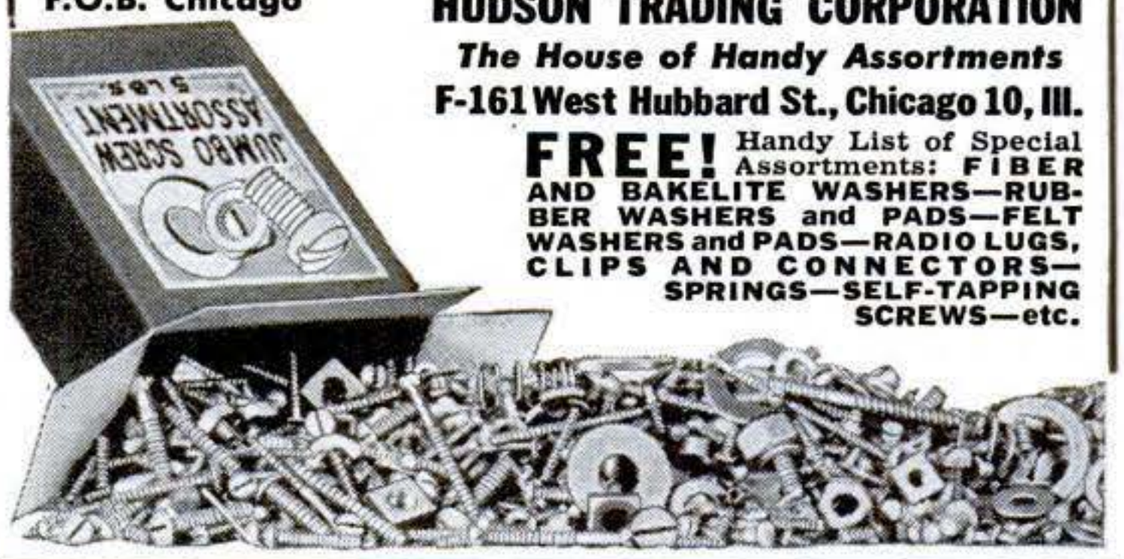

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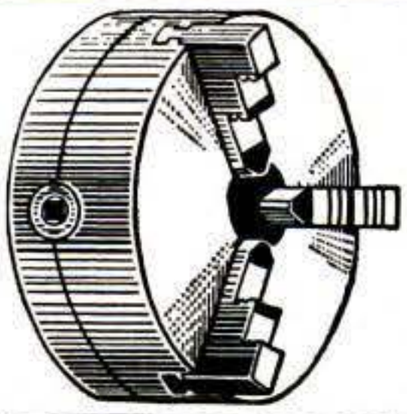

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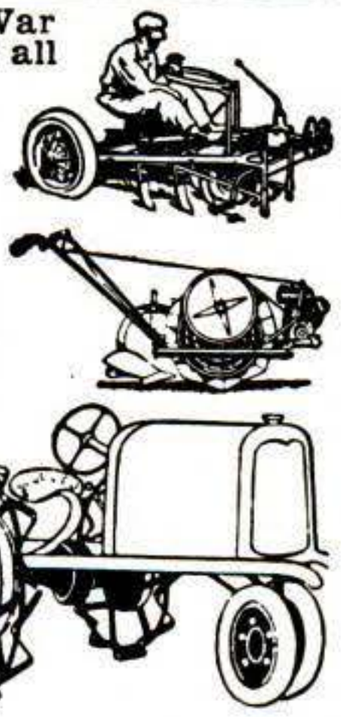

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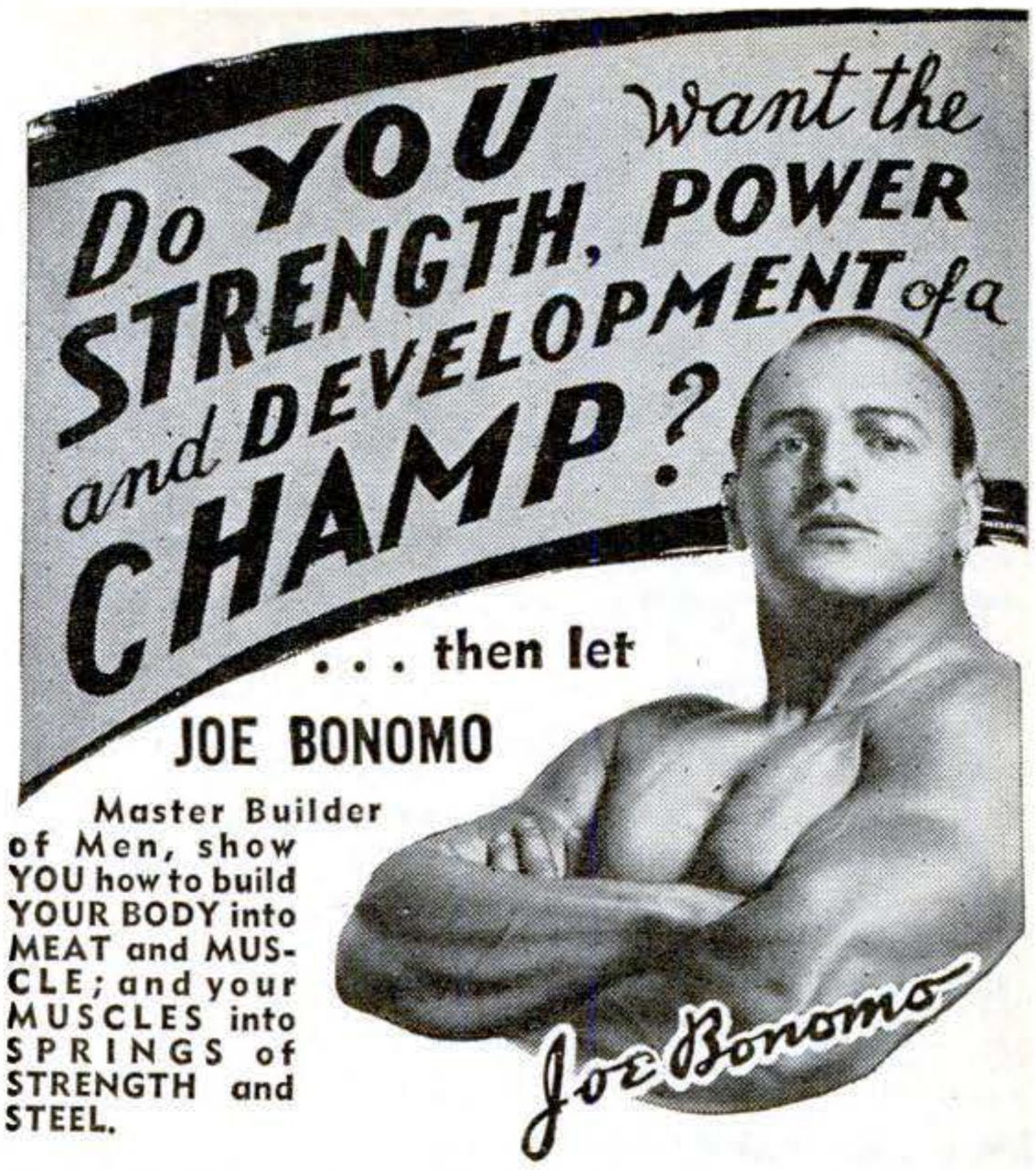

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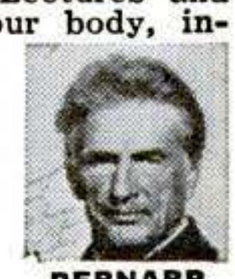

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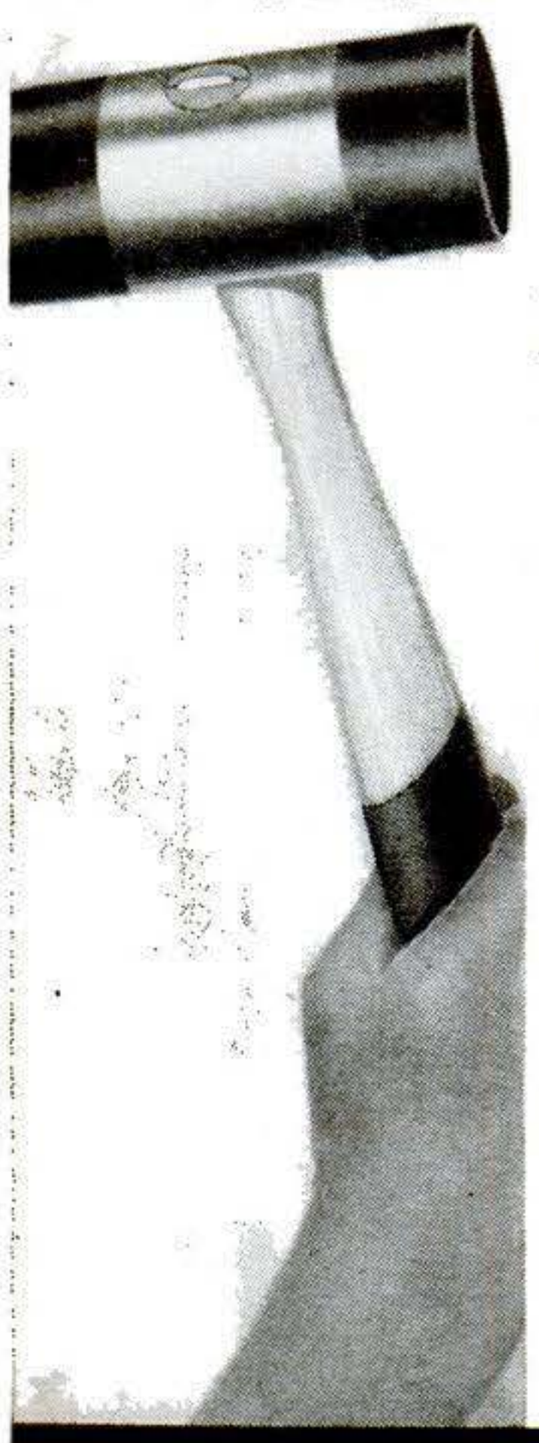

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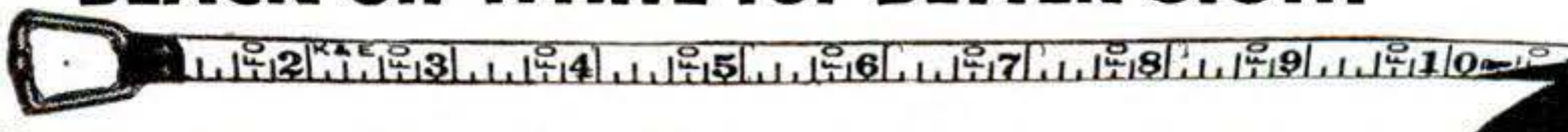

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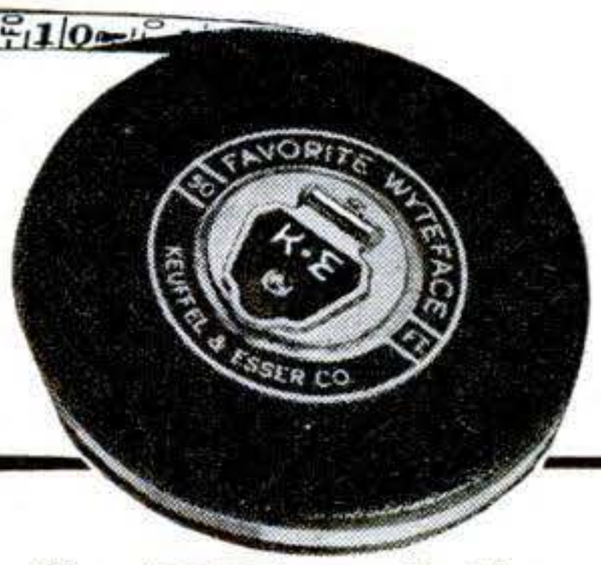

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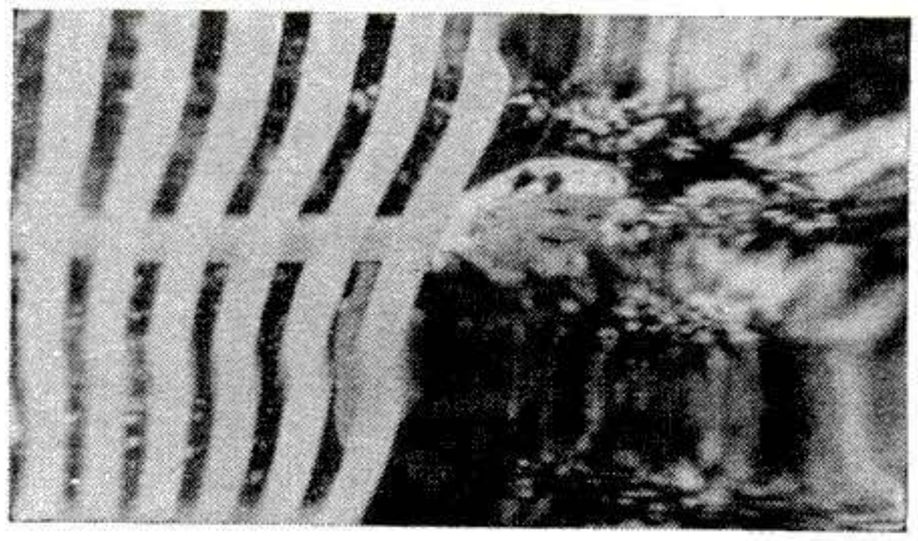

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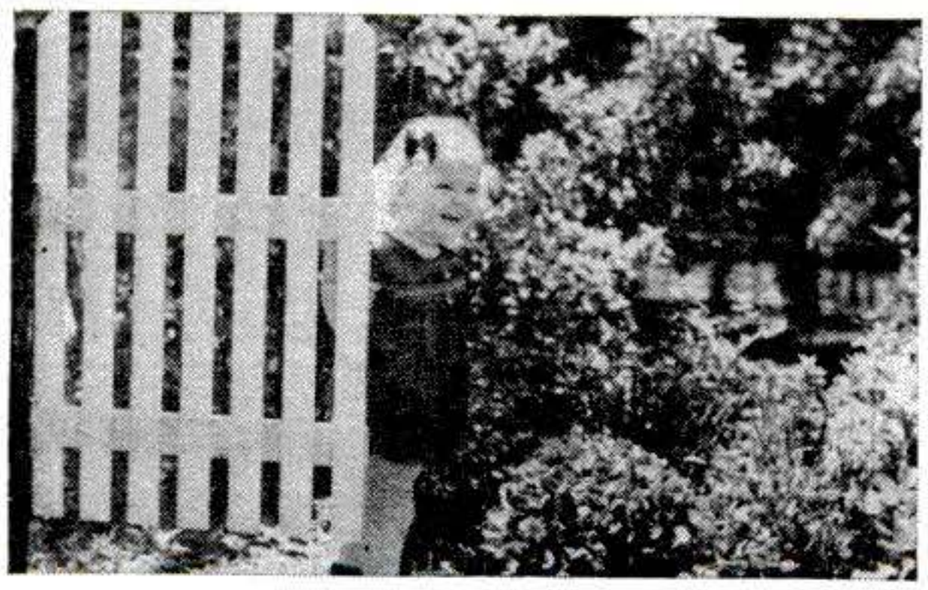

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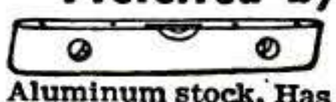

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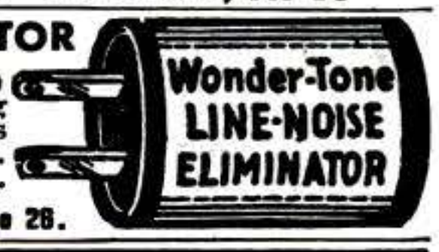

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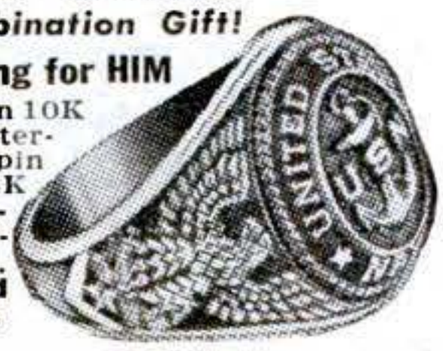

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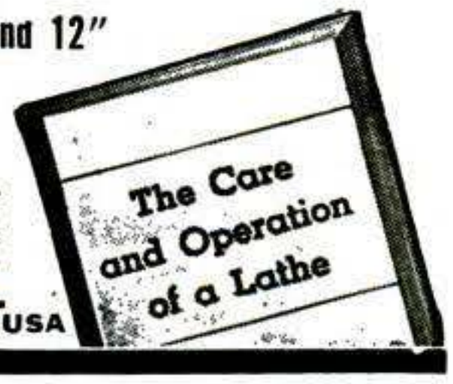

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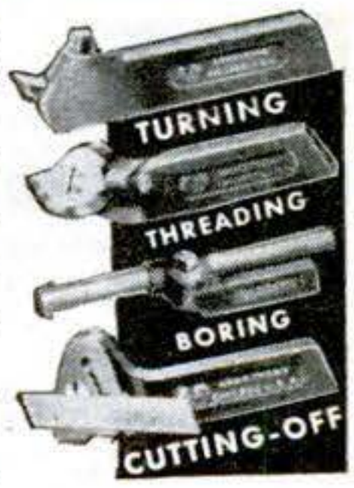

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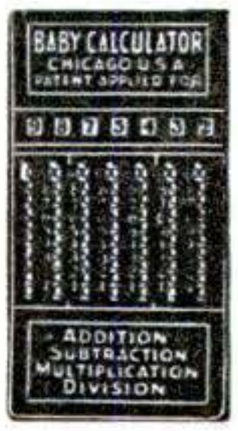

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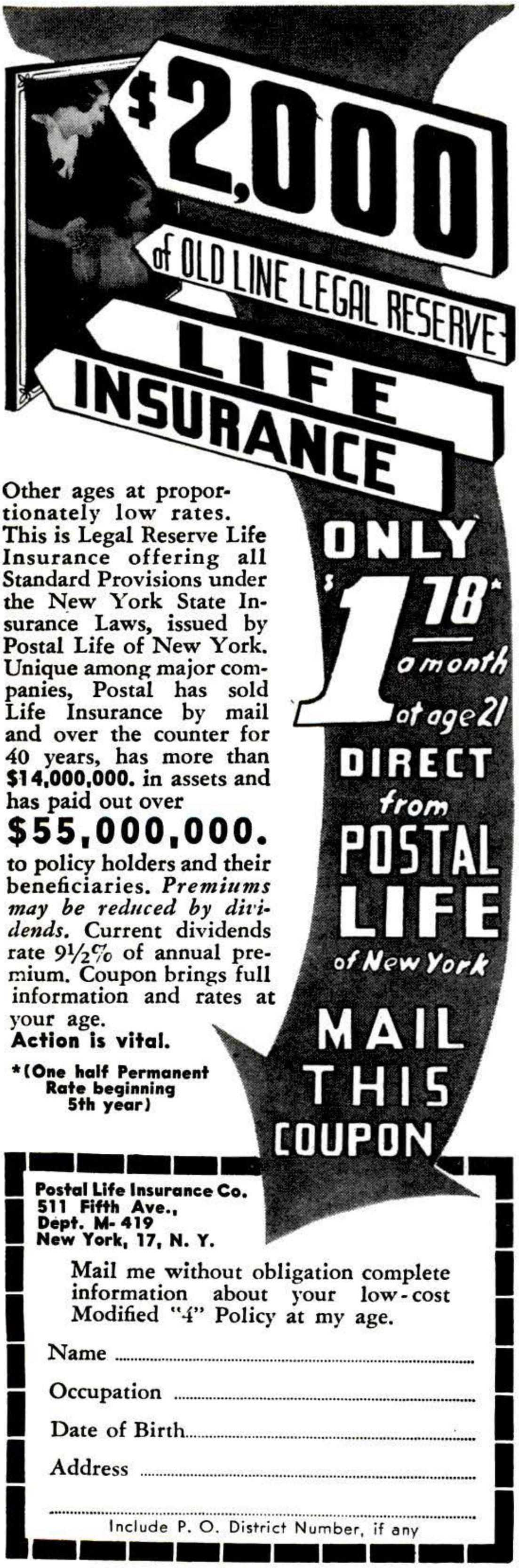

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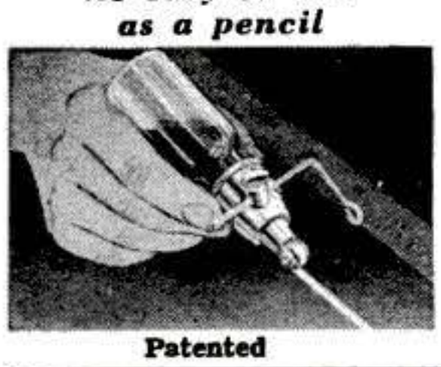

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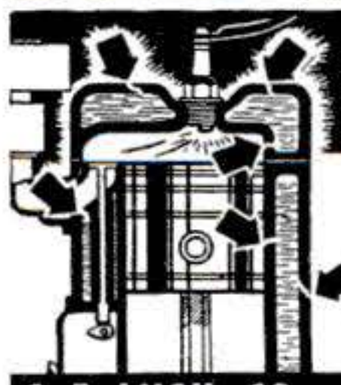

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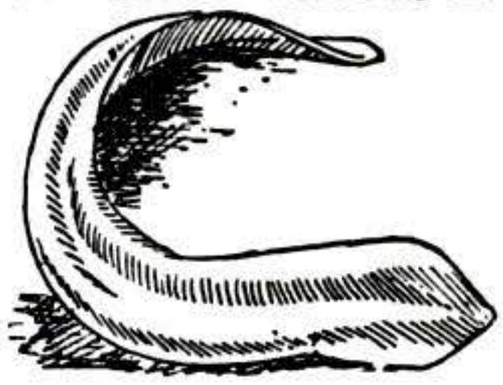

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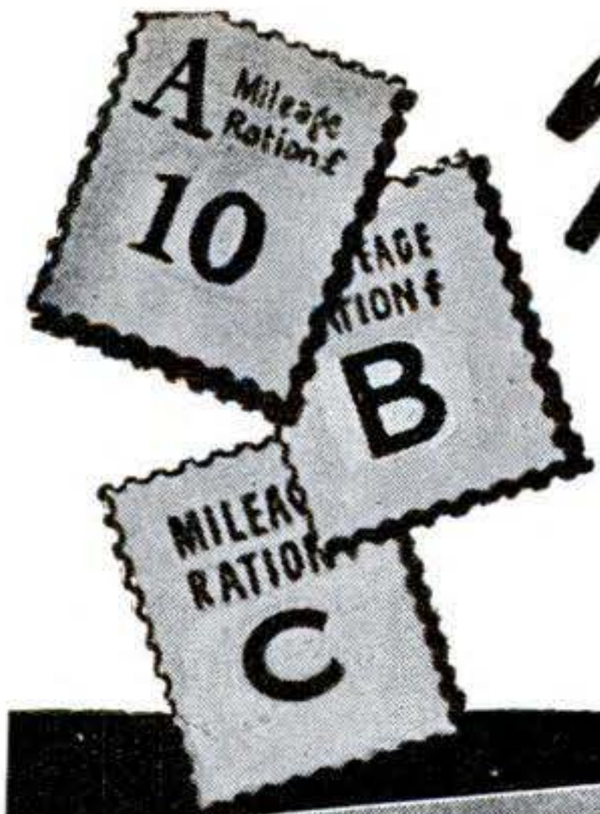

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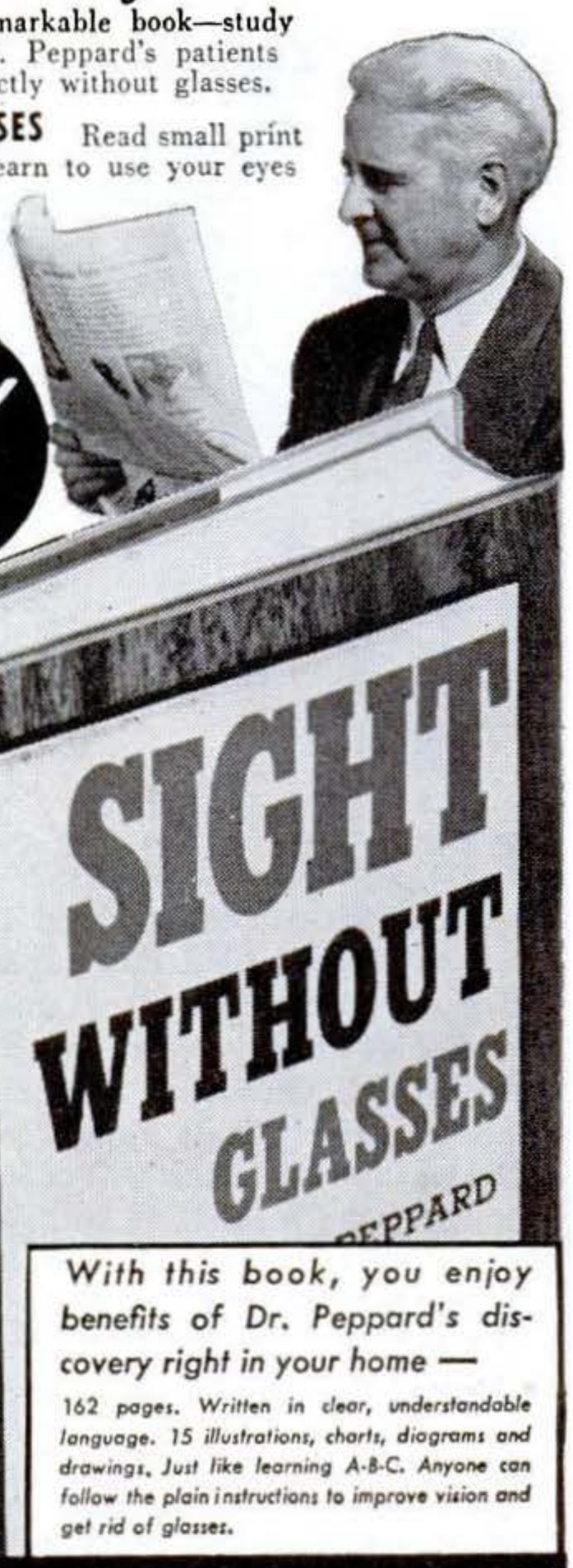

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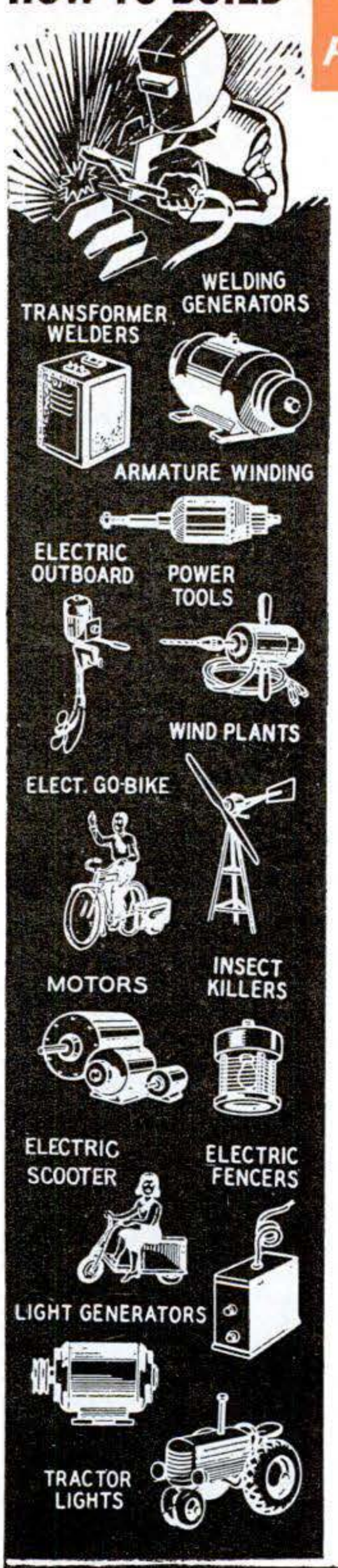

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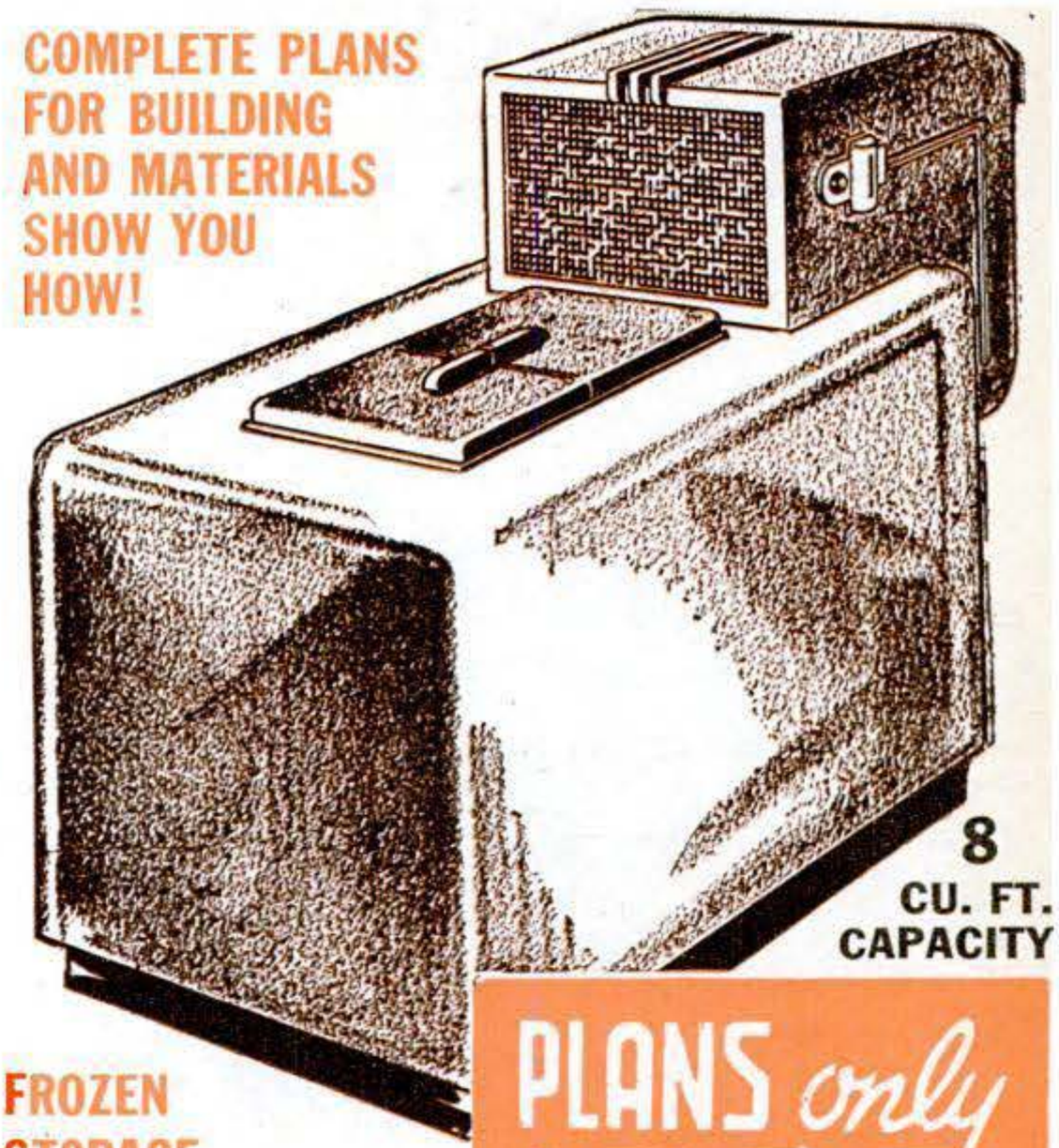

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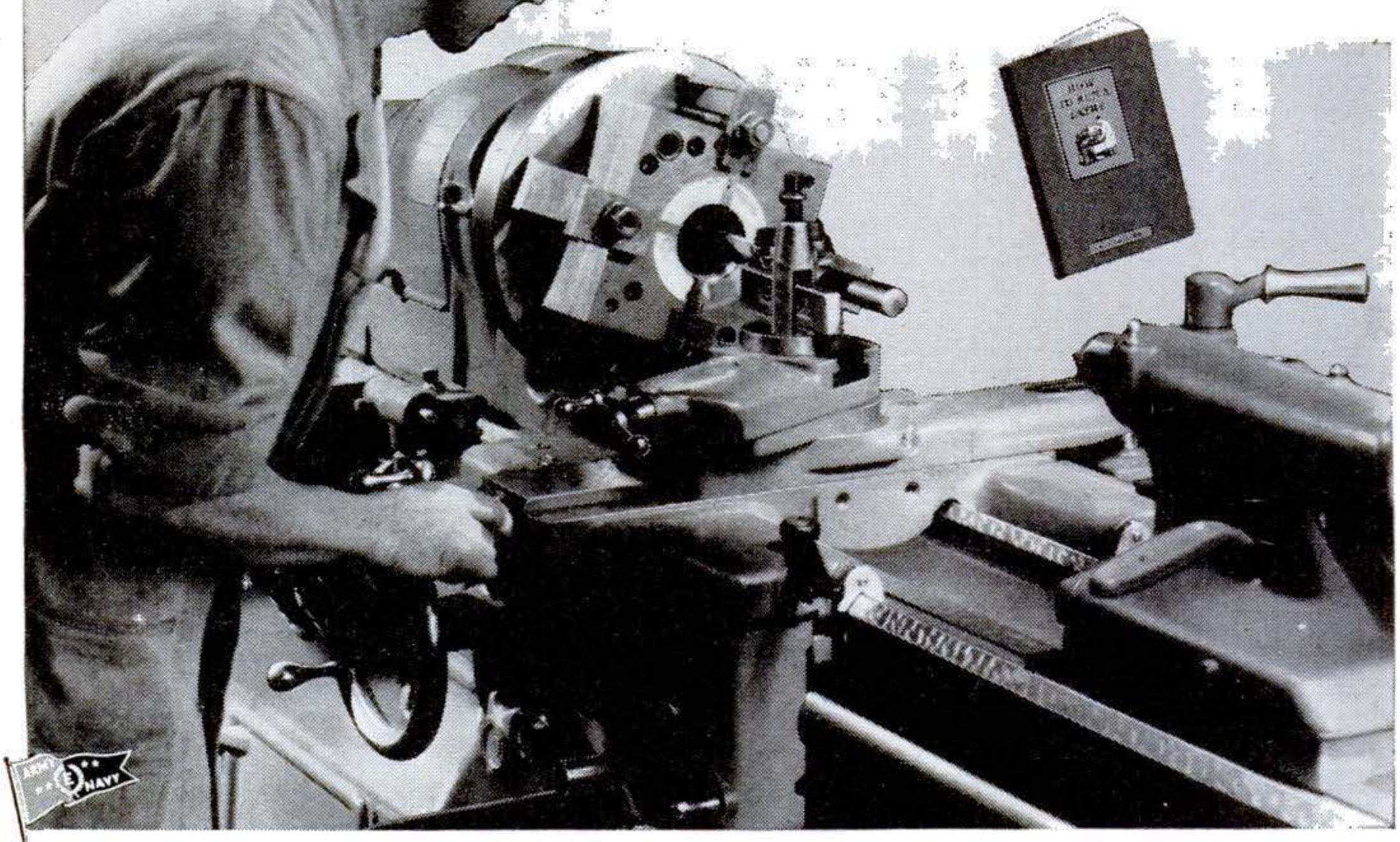

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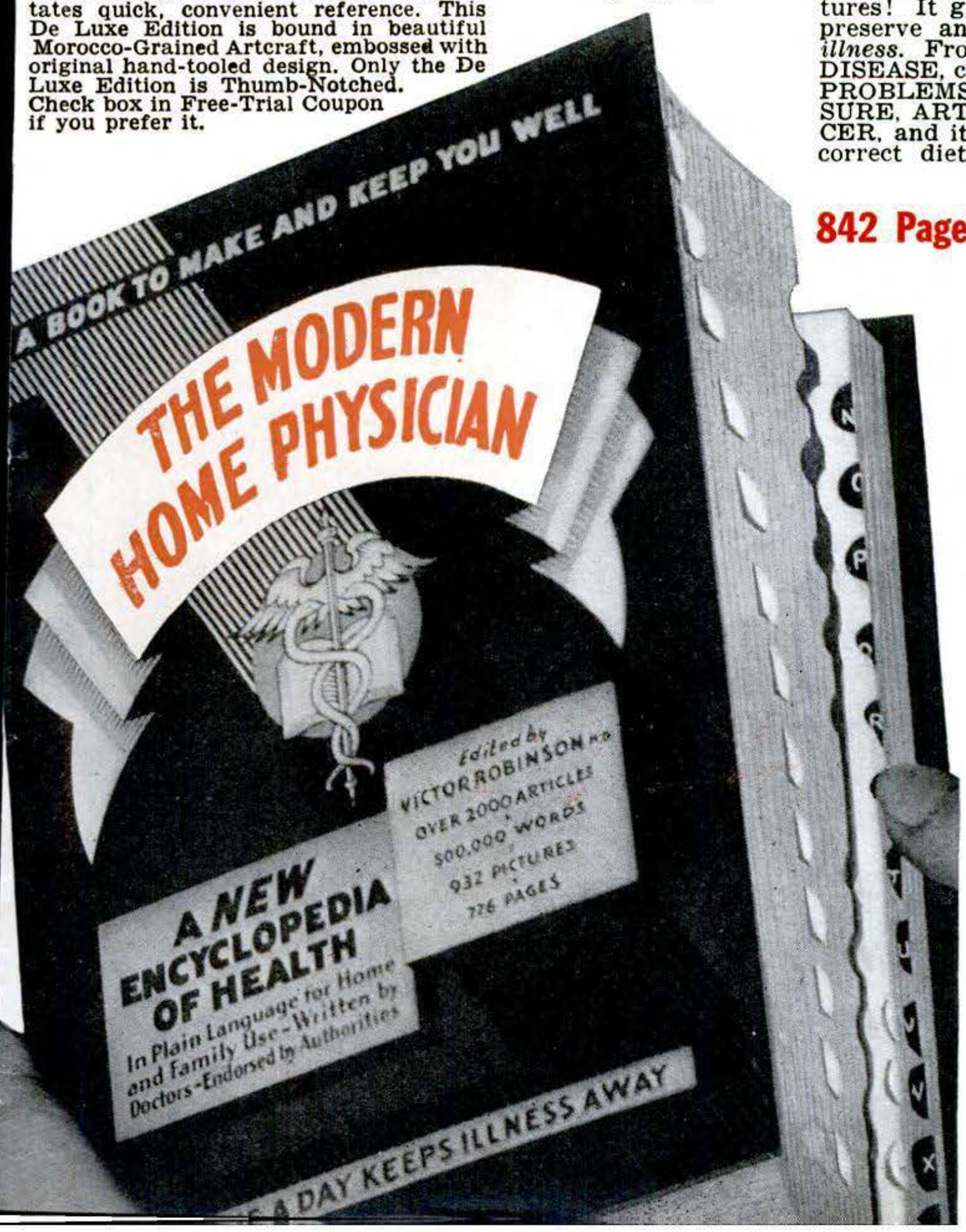

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